

United States Patent [19]

Oshima et al.

[11] Patent Number:

5,600,672

Date of Patent:

Feb. 4, 1997

OTHER PUBLICATIONS

Shanmugam, "Digital and Analog Communication Systems" 1979, p. 272.

Primary Examiner—Stephen Chin Assistant Examiner-Hai H. Phan

Attorney, Agent, or Firm-Wenderoth, Lind & Ponack

ABSTRACT

At the transmitter side, carrier waves are modulated according to an input signal for producing relevant signal points in a signal space diagram. The input signal is divided into, two, first and second, data streams. The signal points are divided into signal point groups to which data of the first data stream are assigned. Also, data of the second data stream are assigned to the signal points of each signal point group. A difference in the transmission error rate between first and second data streams is developed by shifting the signal points to other positions in the space diagram expressed at least in the polar coordinate system. At the receiver side, the first and/or second data streams can be reconstructed from a received signal. In TV broadcast service, a TV signal is divided by a transmitter into low and high frequency band components which are designated as first and second data streams respectively. Upon receiving the TV signal, a receiver can reproduce only the low frequency band component or both the low and high frequency band components, depending on its capability. Furthermore, a communication system based on an OFDM system is utilized for data transmission of a plurality of subchannels, wherein the subchannels are differentiated by changing the length of a guard time slot or a carrier wave interval of a symbol transmission time slot, or changing the transmission electric power of the carrier.

12 Claims, 178 Drawing Sheets

4,963 11/	1992 Lawrence et al	375/265	12 Claims	, 178 Drawing Sneets
[TRANSMITTER 742	, 852a	(1
	VIDEO ENCODER	1ST DATA STREAM INPUT ,743a ,743a ,743a ,743a ,743a ,743a ,743c ,7	MODULATOR 749	
(HDTV) -	1ST VIDEO ENCODER , 401b 2ND VIDEO ENCODER	ECC 2ND DATA STREAM INPUT 7443 TRELLIS ECC PNCODER 7447 7441 7440 7441	rnodulator VSB QAM PSK	TRANSMITTING CIRCUIT ,5a TRANSMITTED SIGNAL
1	VIDEO DECODER	RECEIVER 757	852b	43 AF
HDTV (SDTV) —	1ST VIDEO DECODER 402a 1ST VIDEO DECODER 2ND VIDEO DECODER	2ND DATA STREAM OUTPUT 2ND DATA STREAM OUTPUT 7592 ECC 7592 TRELLIS ENCODER 759	demodulator VSB QAM PSK	DOWN CONVERTER

[54] COMMUNICATION SYSTEM

[75] Inventors: Mitsuaki Oshima, Kyoto; Seiji

Sakashita, Osaka, both of Japan

[73] Assignce: Matsushita Electric Industrial Co.,

Ltd., Osaka, Japan

[21] Appl. No.: 240,521

May 10, 1994 [22] Filed:

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 857,627, Mar. 25, 1992.

A . - 1: -- Alan Delouity Data

[30] For	Foreign Application Priority Data		ion Priority Data
Mar. 27, 1991	(JP)	Jánan	3-62798
Apr. 25, 1991	[JP]	Ianan	3-95813
May 29, 1991	(JP)	Japan	3-155650
Jul. 23, 1991	ίμεί	Ianan	3-182236
Mar. 17, 1992	(JP)	Ianan	4-60739
May 10, 1993	igri	Ianan	5-132984
Sep. 24, 1993	(JP)	Ianan	5-261612
Dec. 27, 1993	[JP]	Ianan	5-349972
Mar. 24, 1994	[JP]	Japan	6-79668
[51] Int. Cl.6			H04L 5/16; H04B 1/38
(S) TIE CI	20000000	•••	375/219; 375/270; 375/301;
[52] U.S. Cl.	**********		375/321
[58] Field of	Search	h	375/219, 259,
•	37	5/260,	261, 262, 265, 270, 240, 321,

References Cited [56]

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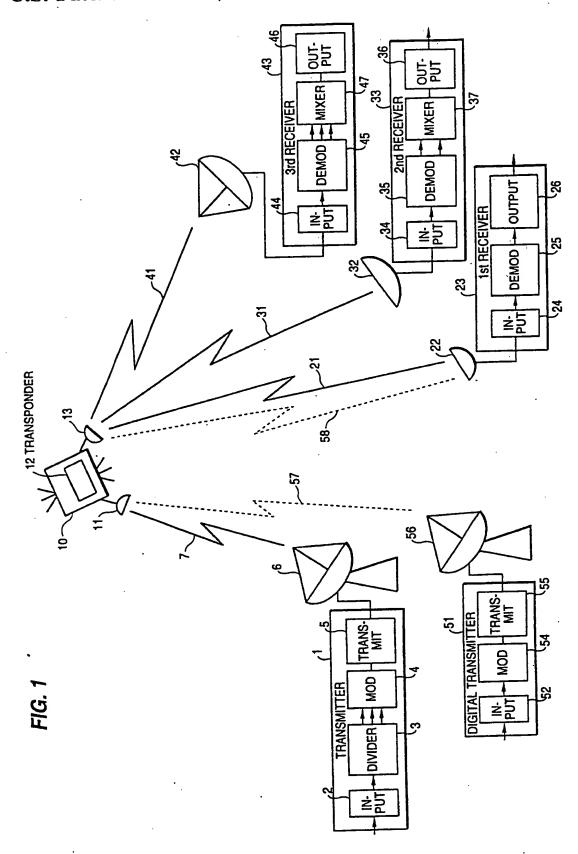
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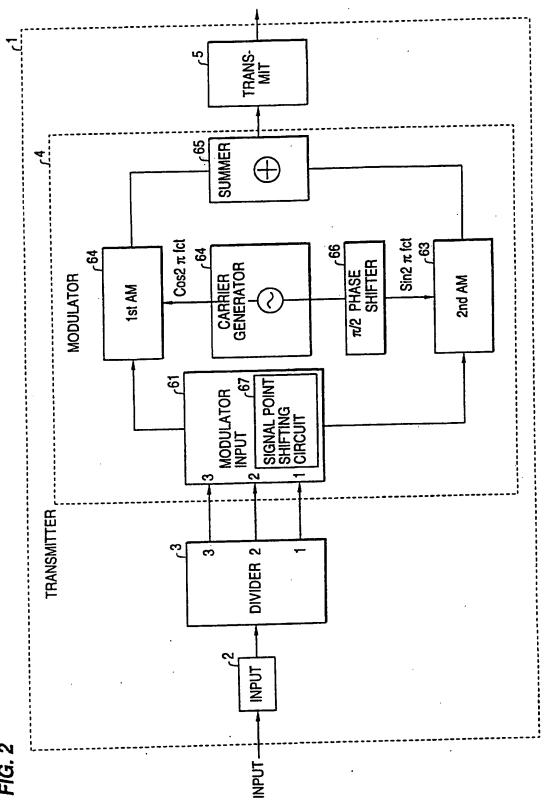
326, 341, 354; 348/725, 726, 723, 724

Feb. 4, 1997

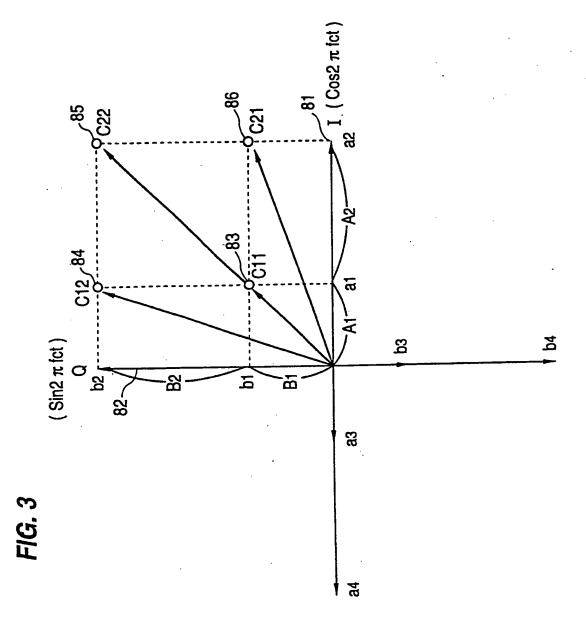
Sheet 1 of 178

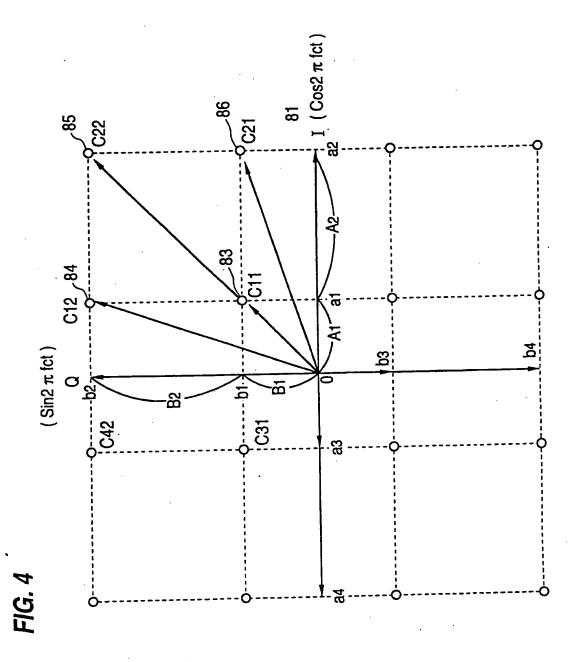
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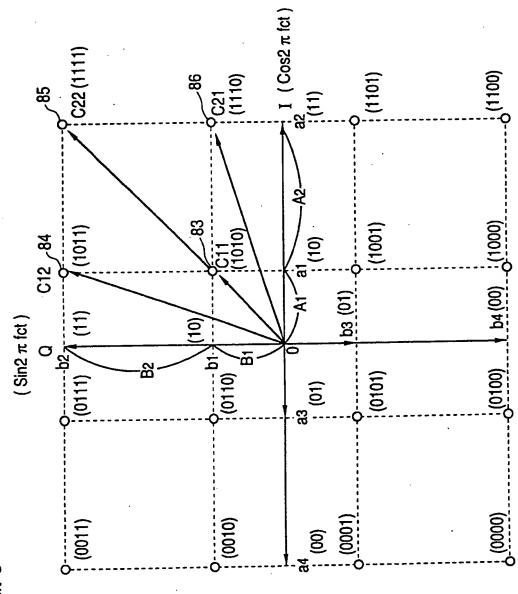


FIG. 5

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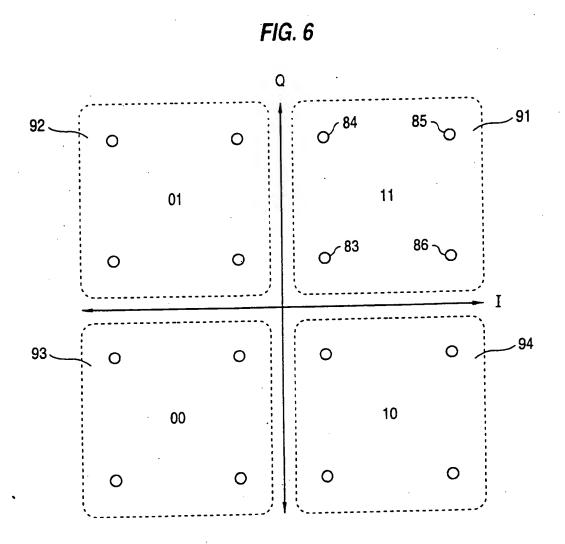


FIG. 7

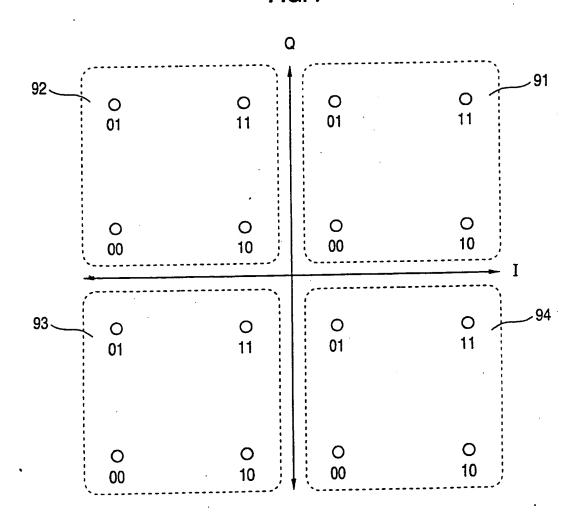


FIG. 8 Q 92 O (11) (11) (01) (01) (11) · (01) .O (10) 0 (10)(00) (00) 94 O (11) 93、 0 0 (11) (01) (01) (10) (00) 0 0 0 0 (10) (00) (10) (00)



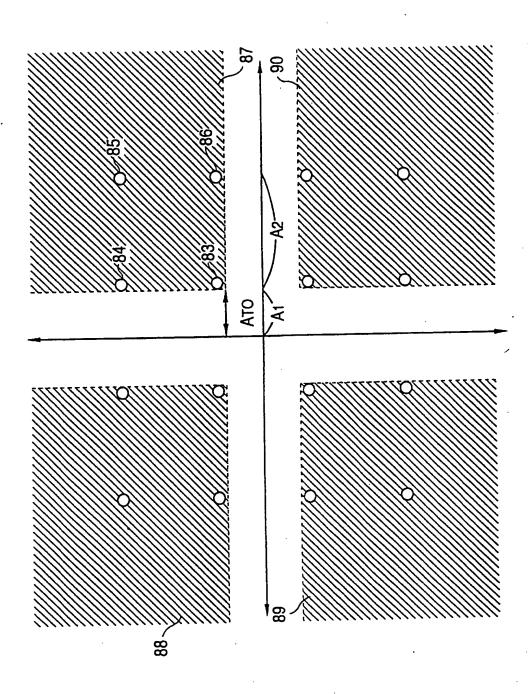


FIG. 10 A(16) 96 B₂ 95 B₁ A(4)

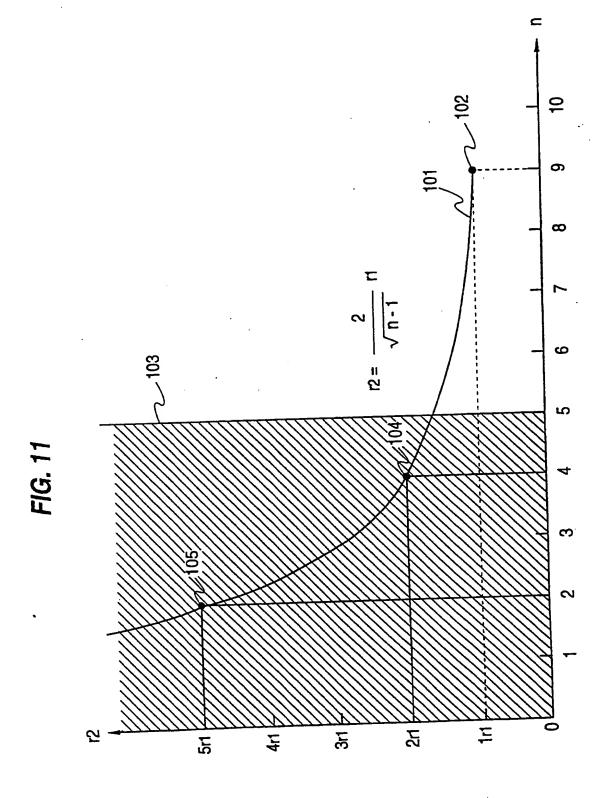
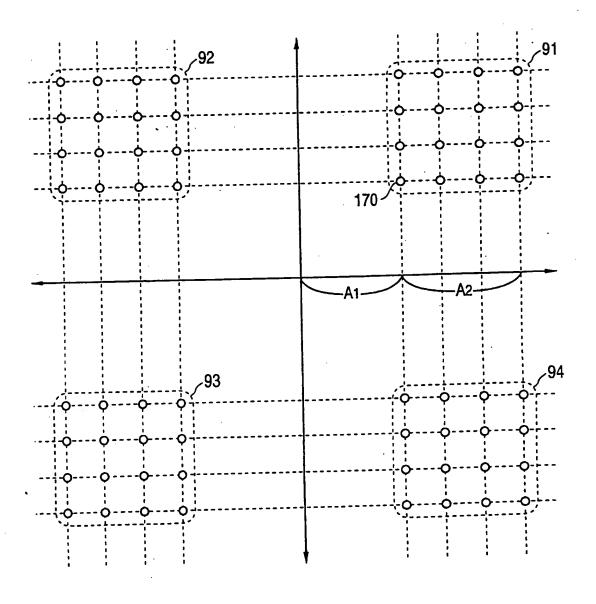
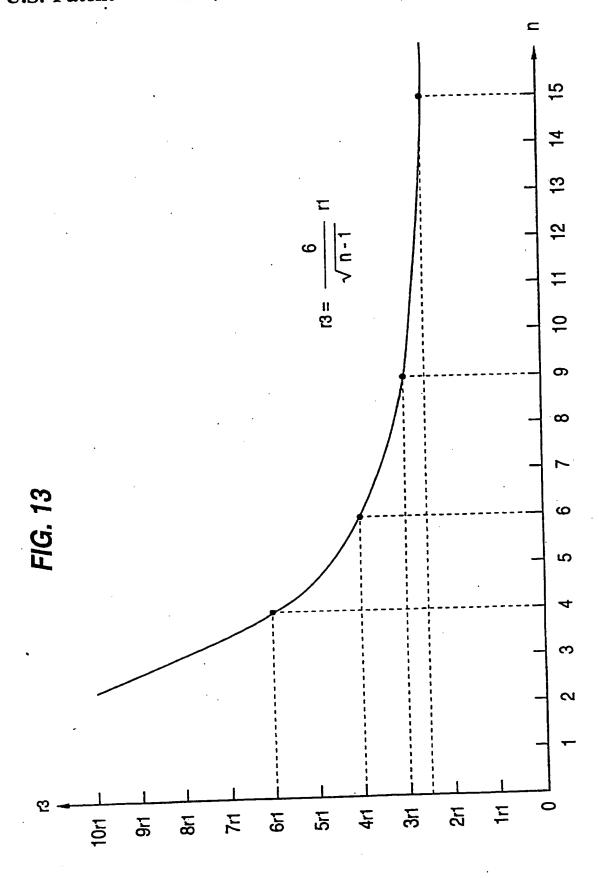


FIG. 12







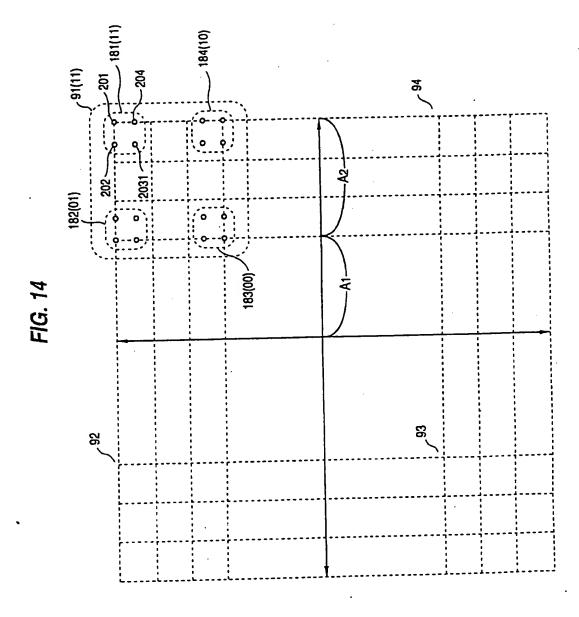
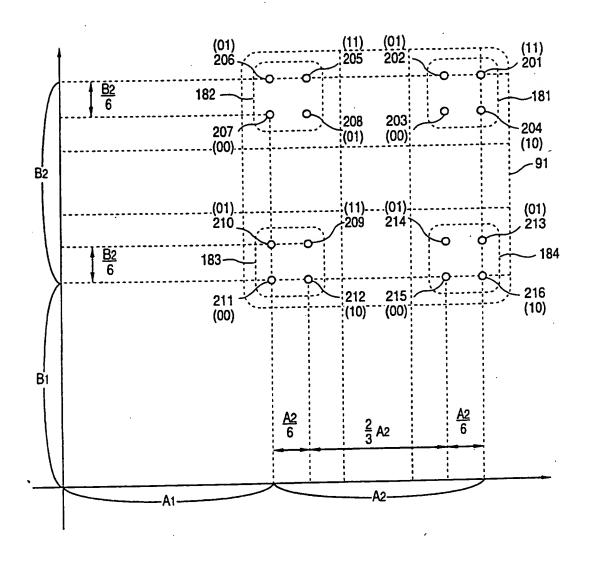
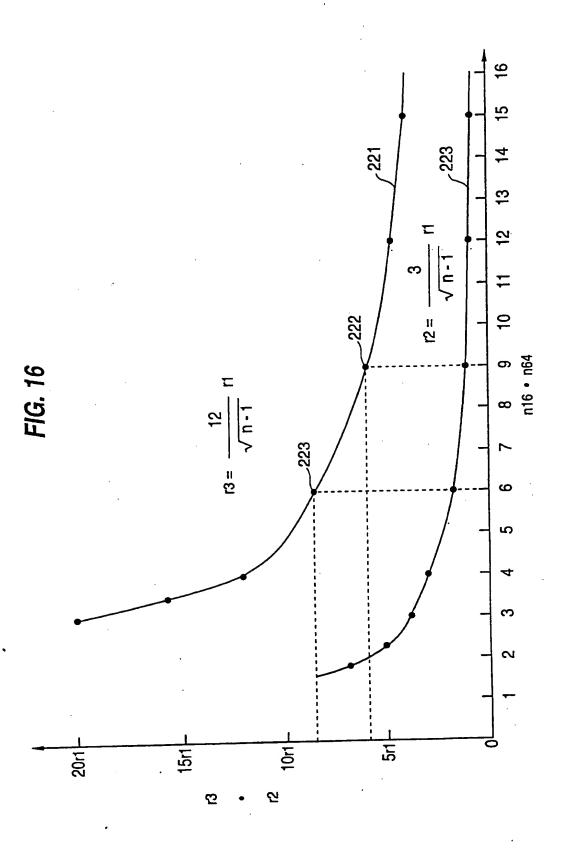


FIG. 15





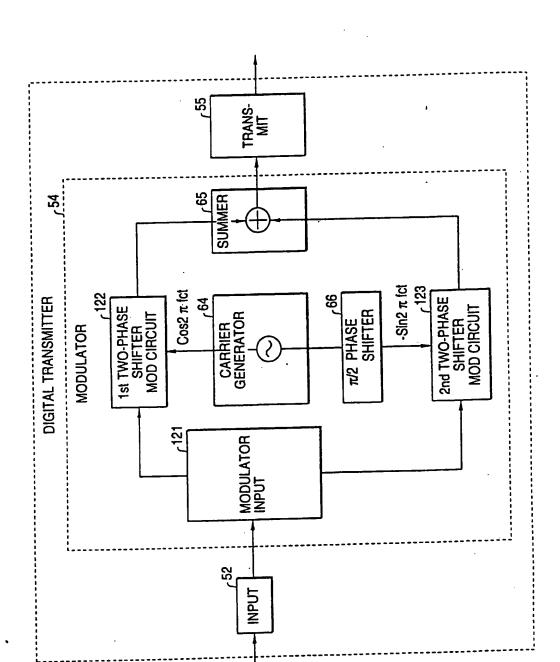
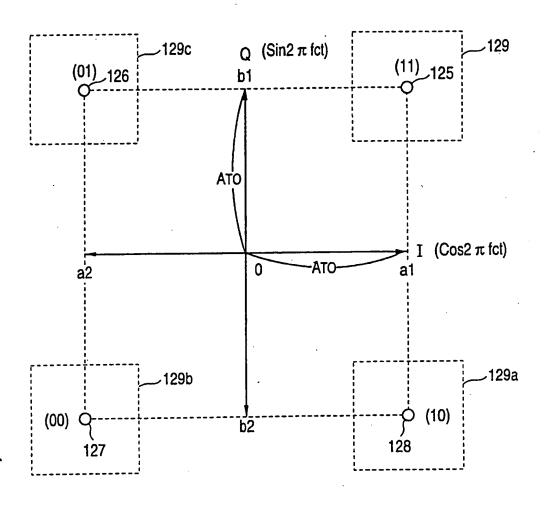
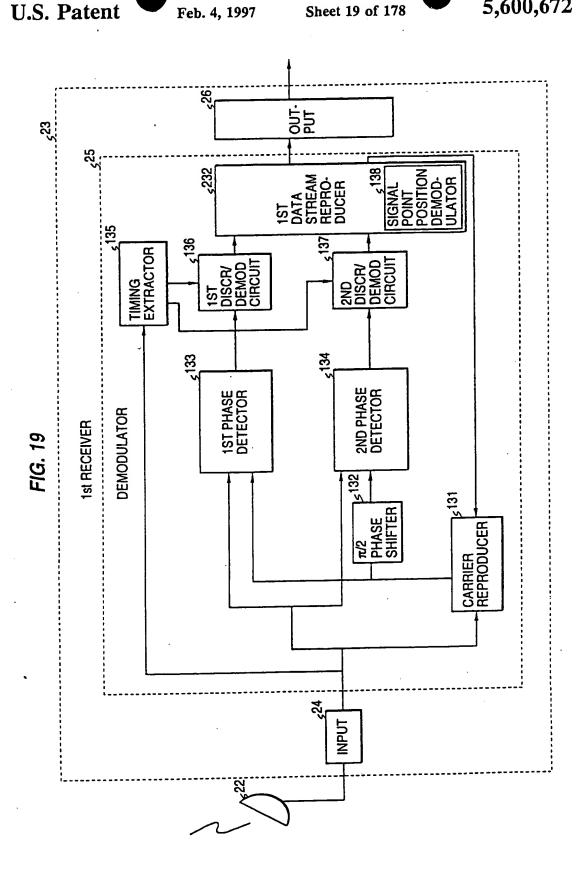


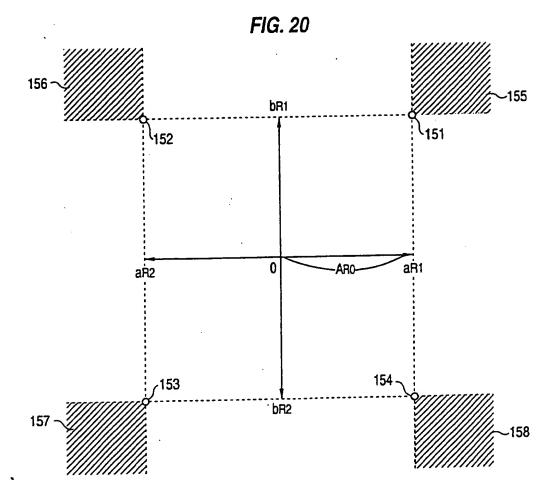
FIG. 17

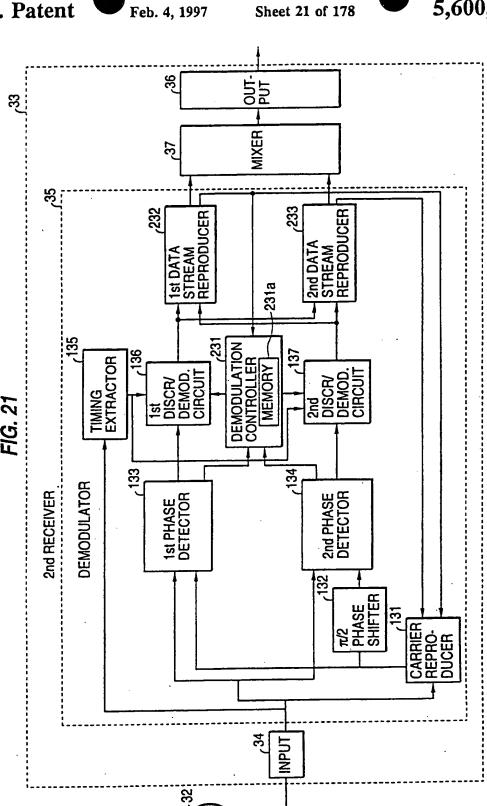
FIG. 18





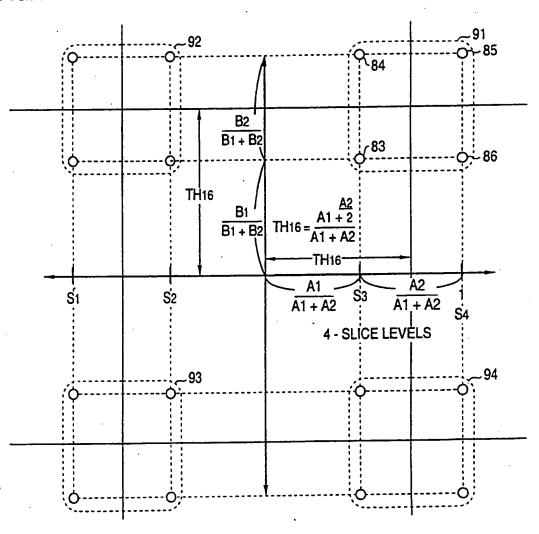


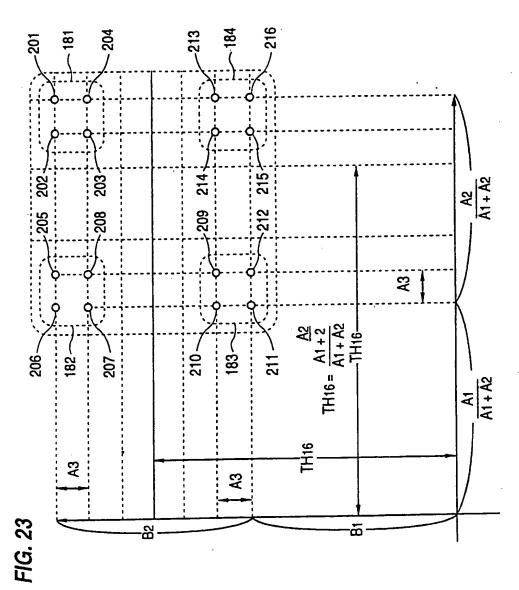




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FIG. 22







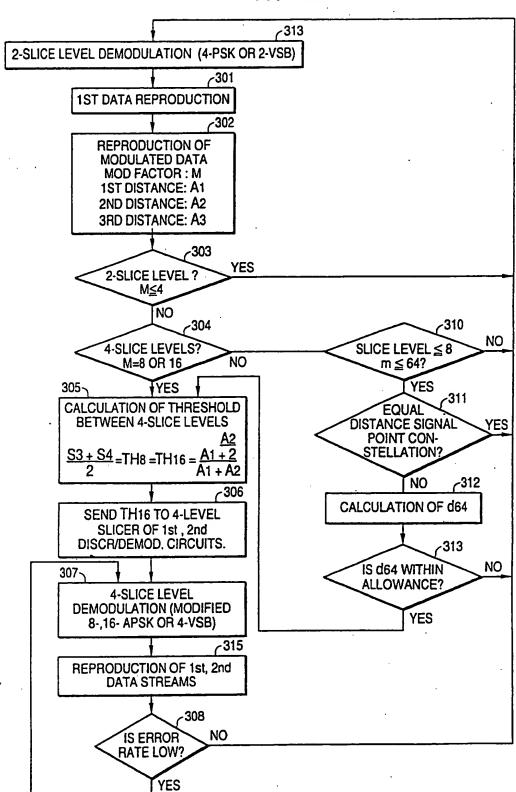


FIG. 25(a)

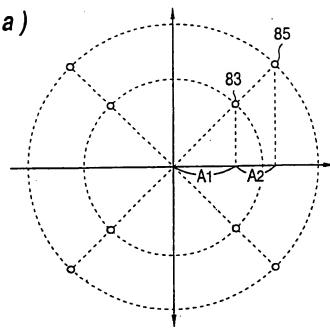
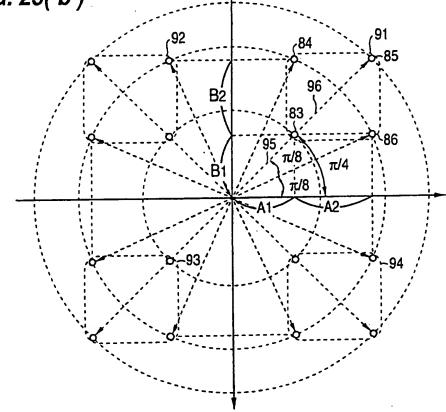
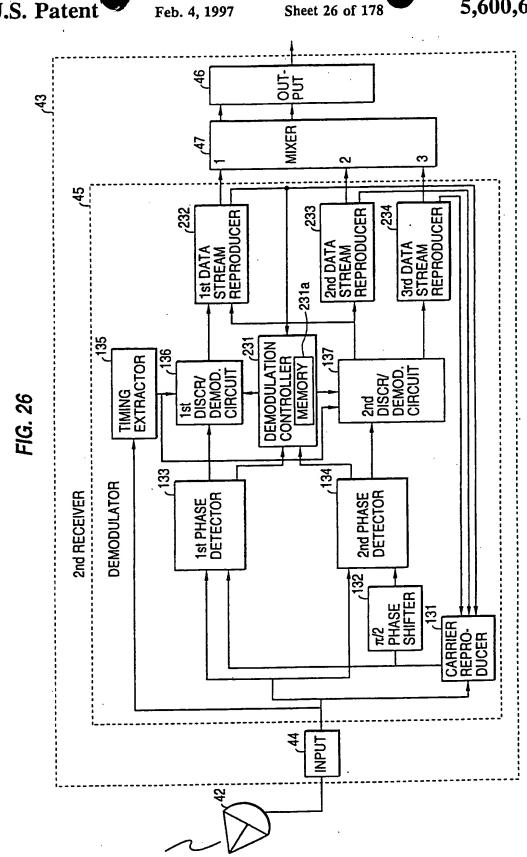


FIG. 25(b)

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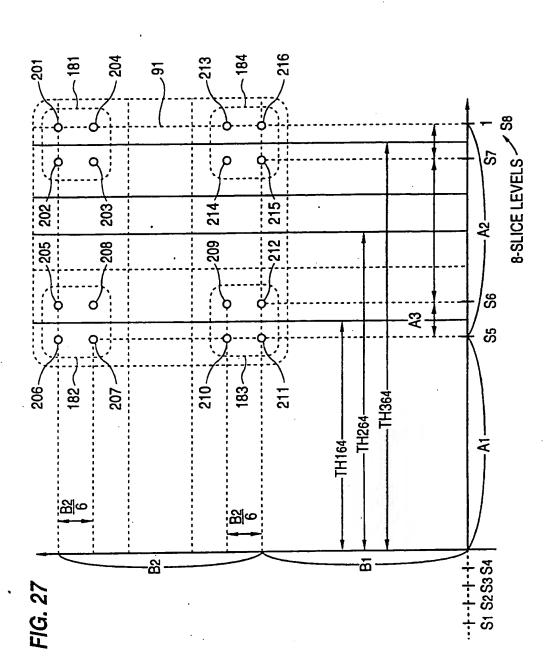
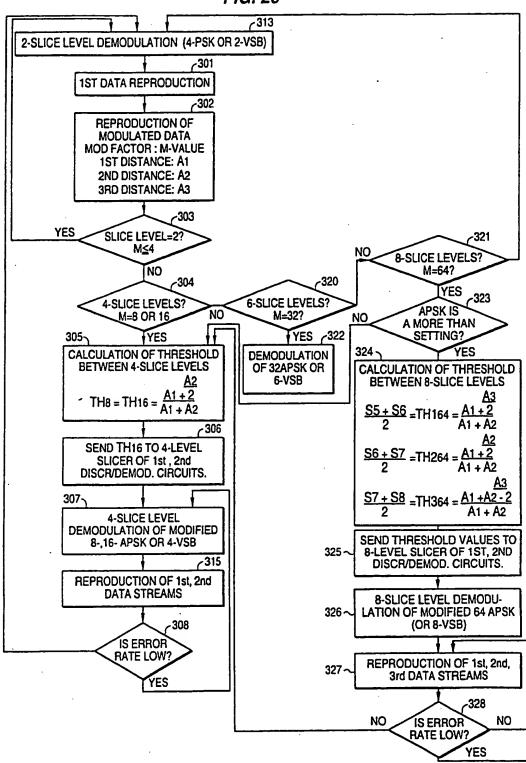
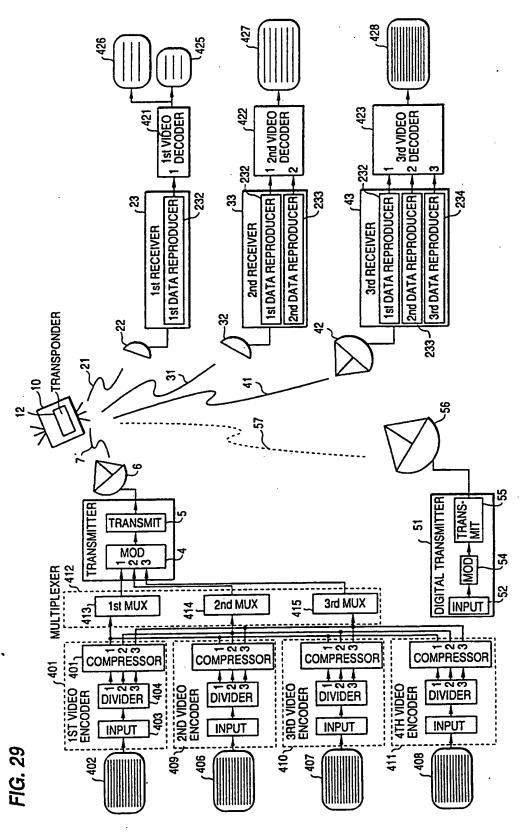




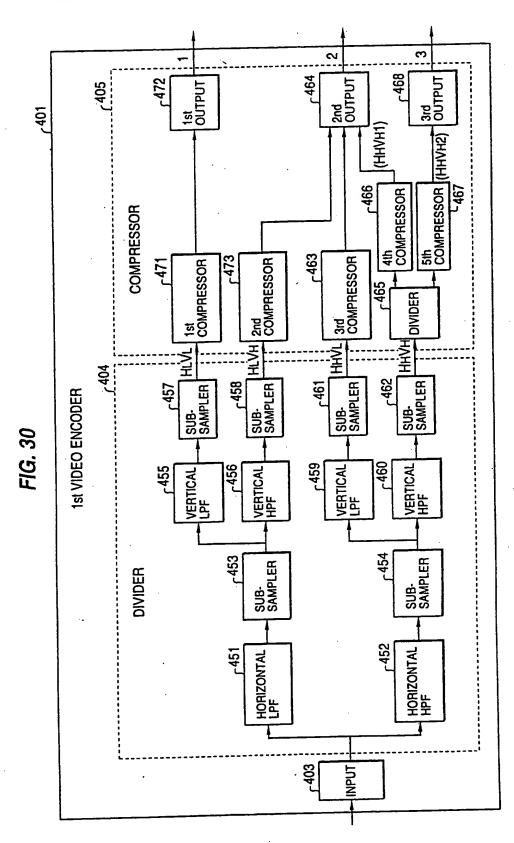
FIG. 28



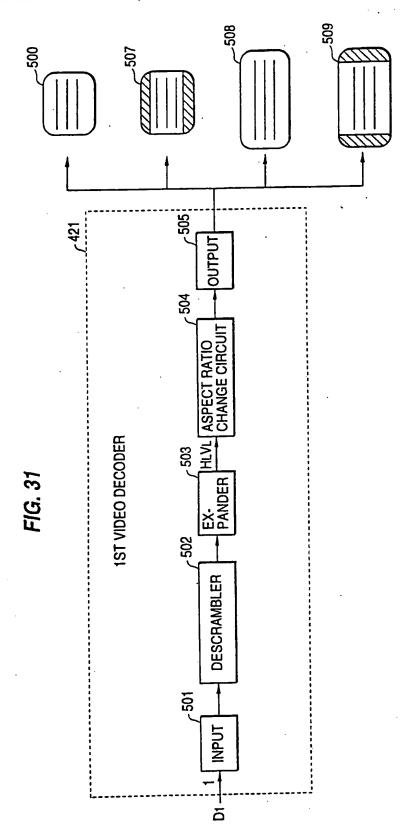


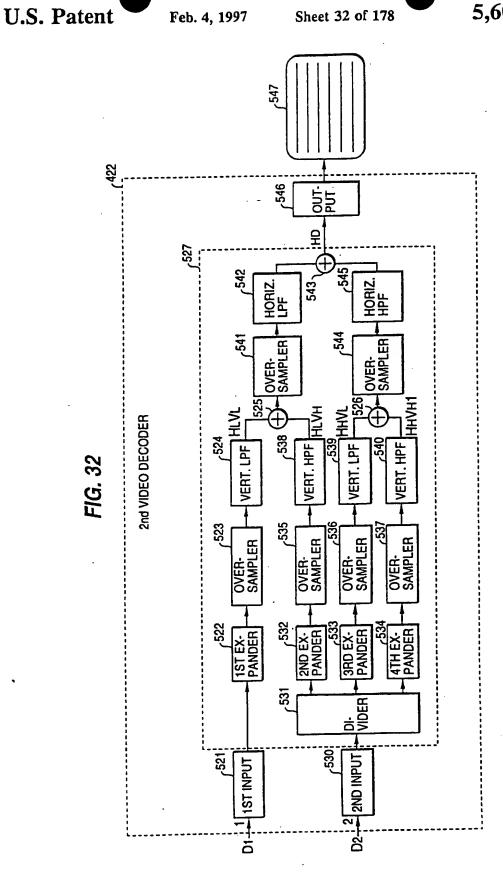


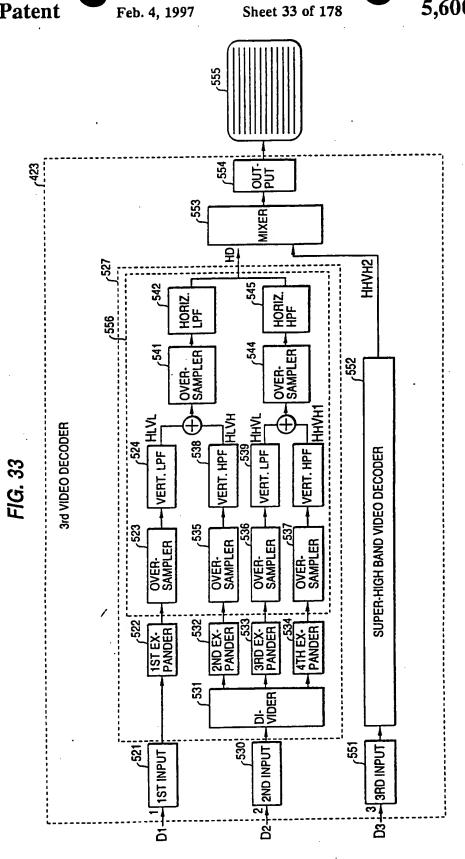


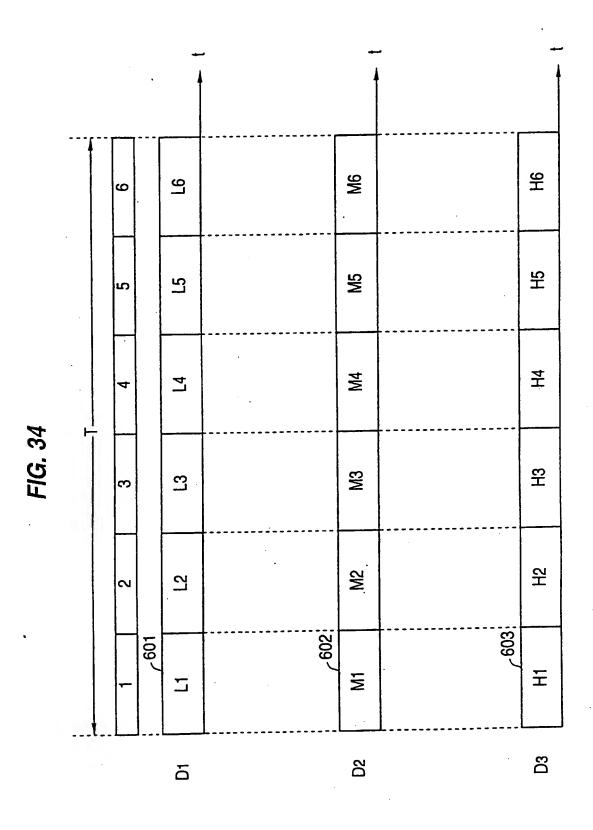




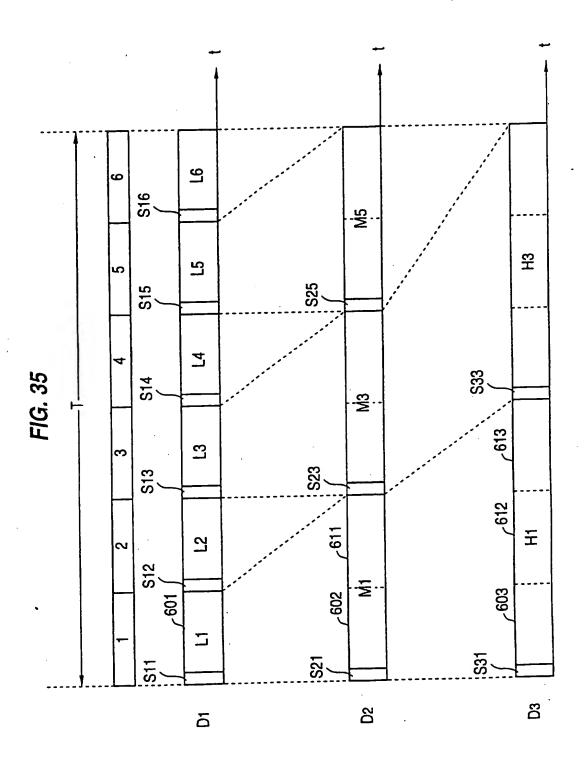




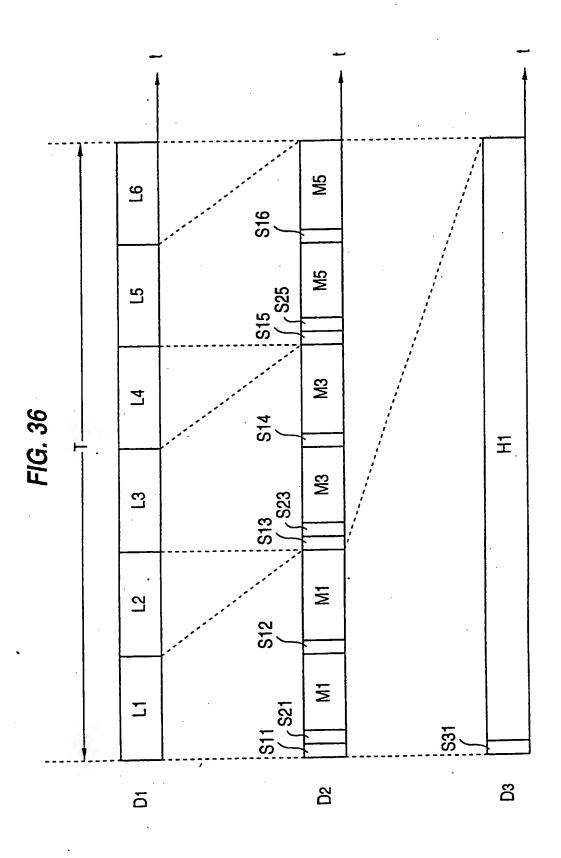


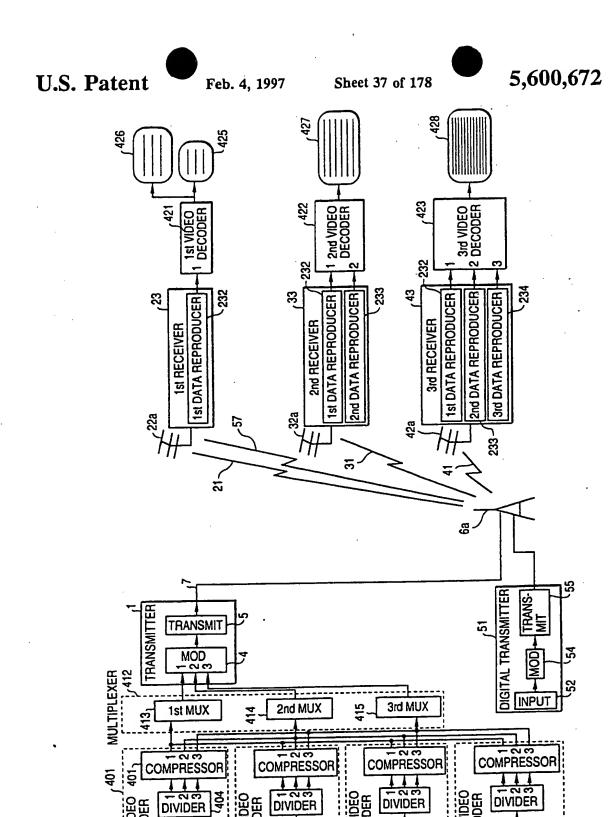












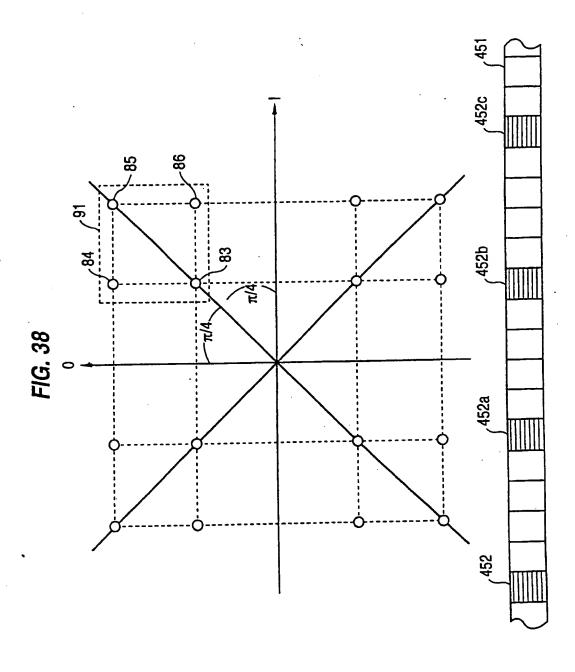
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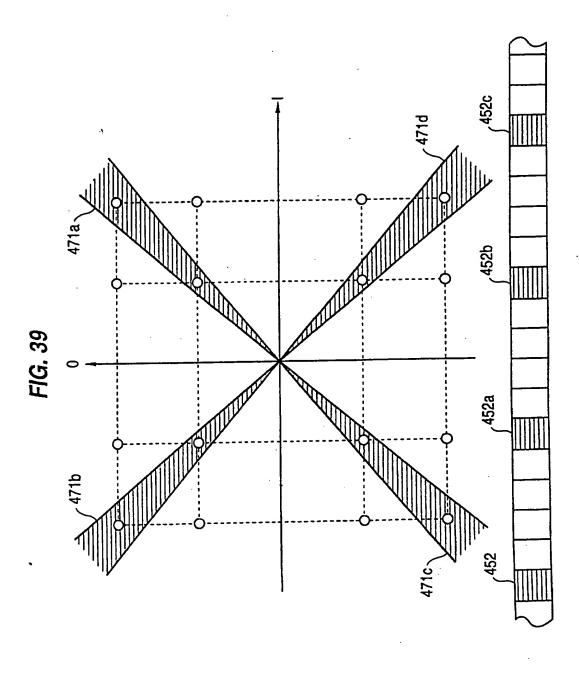
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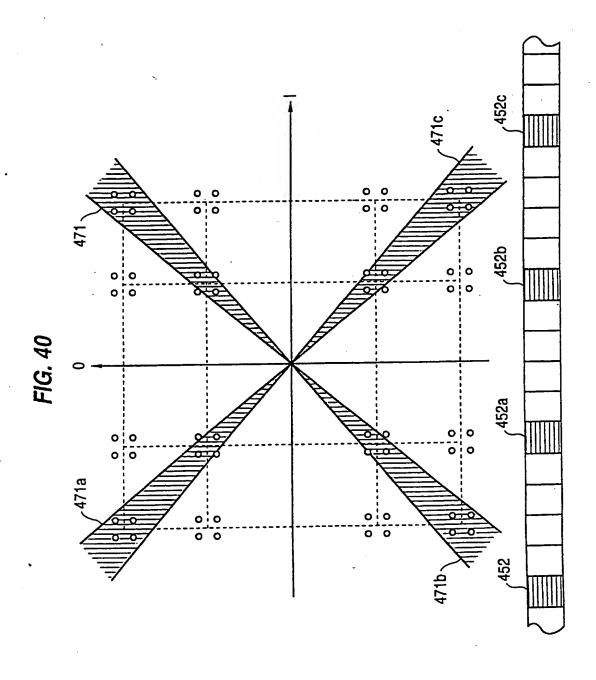
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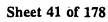
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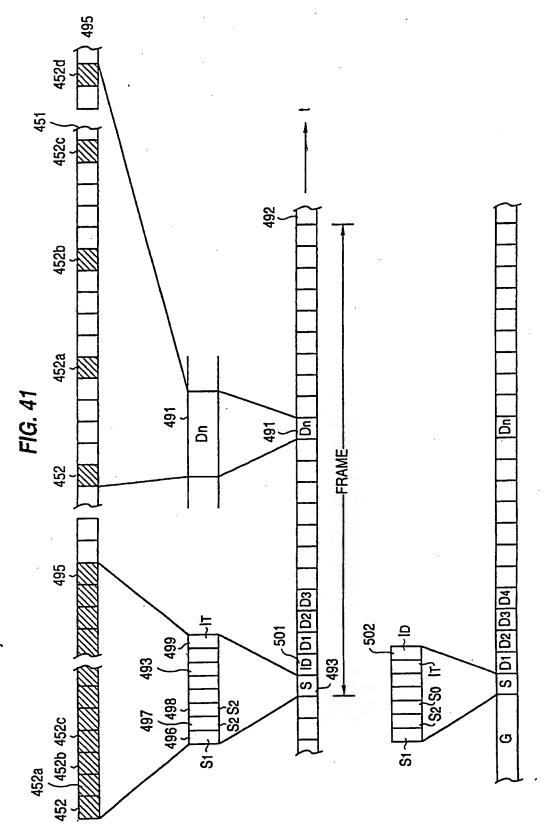
FIG. 37



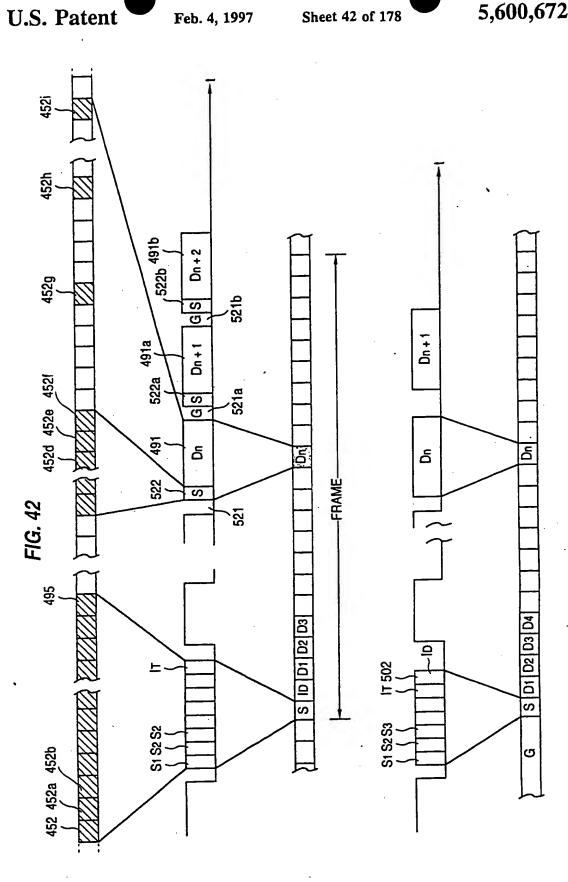


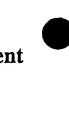


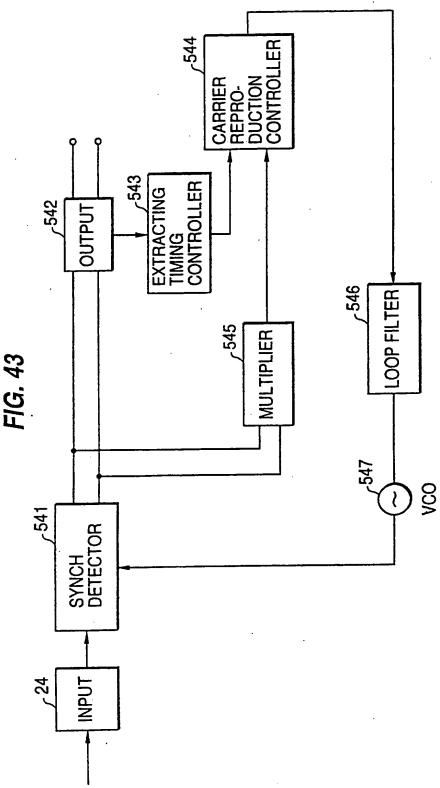


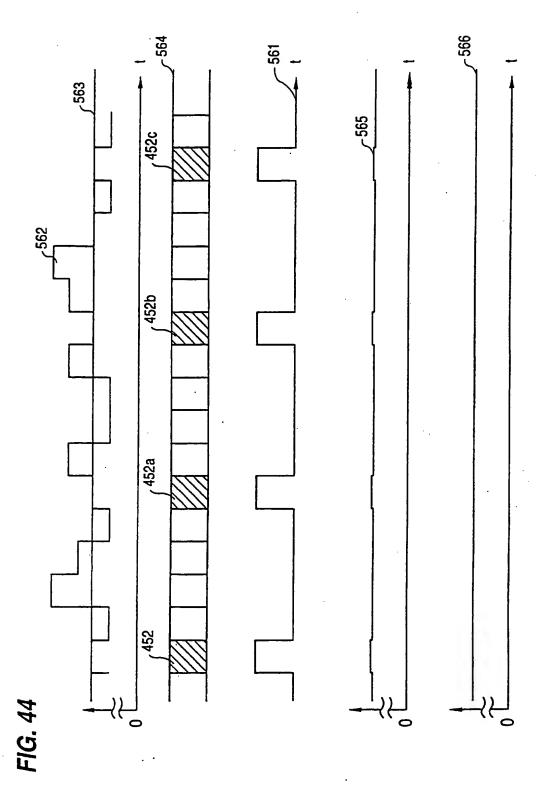


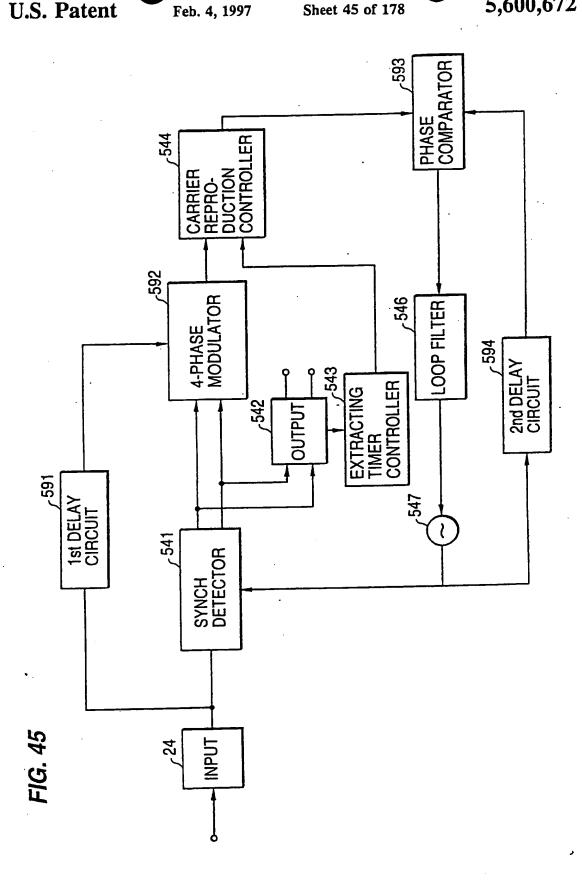
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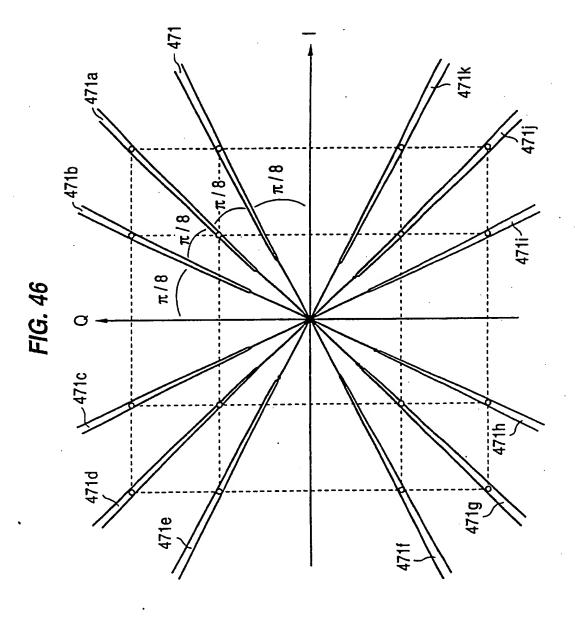


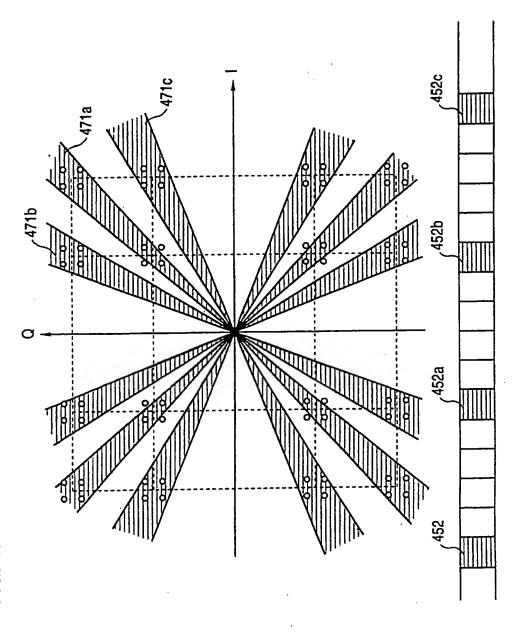


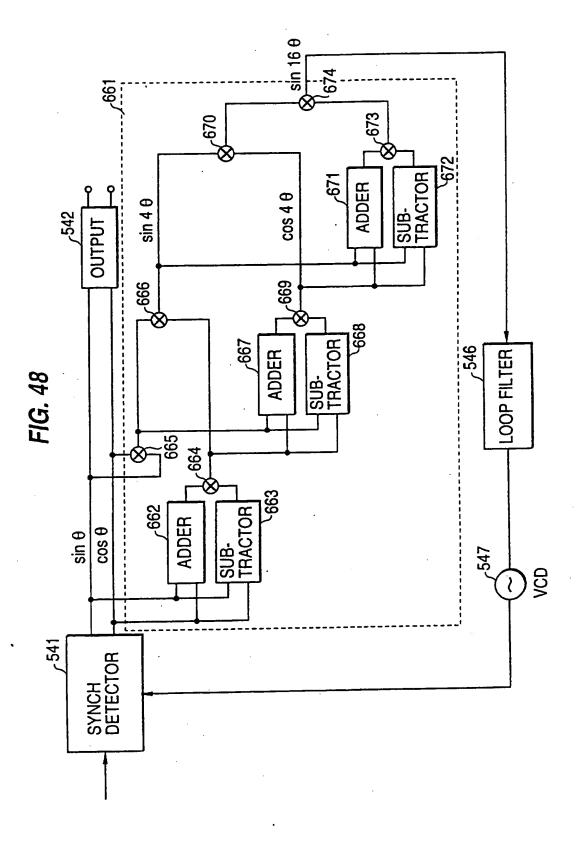






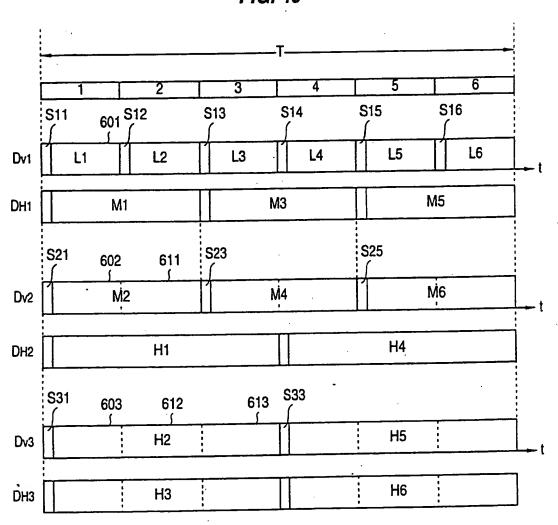




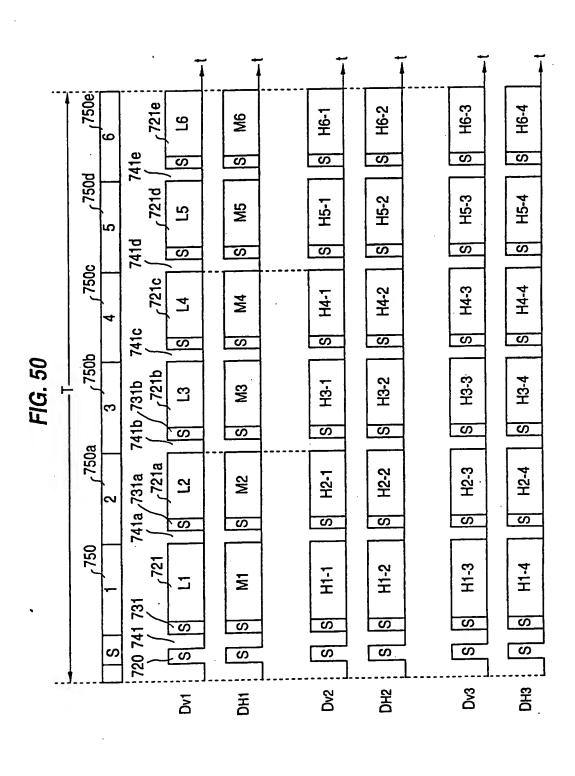


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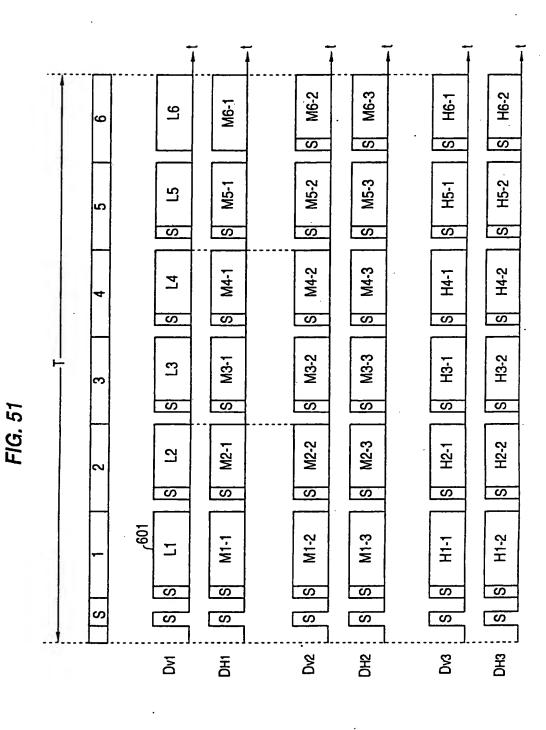
FIG. 49



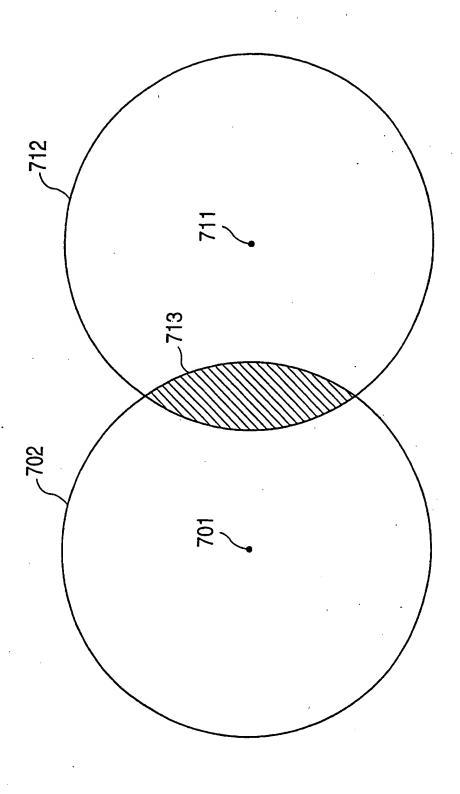
U.S. Patent



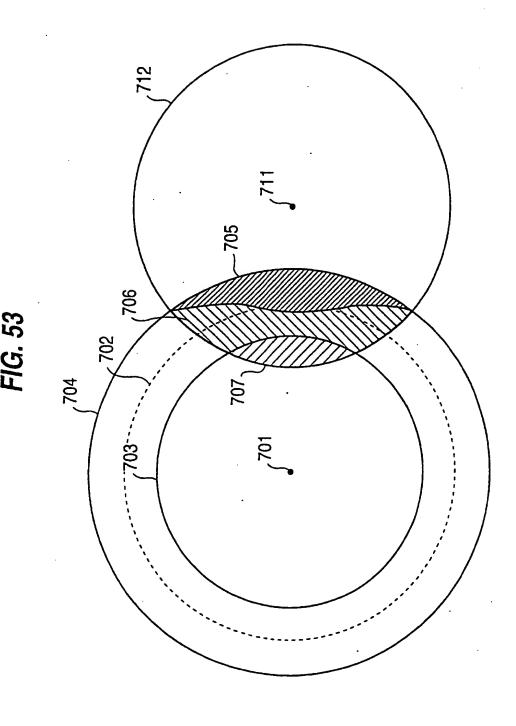


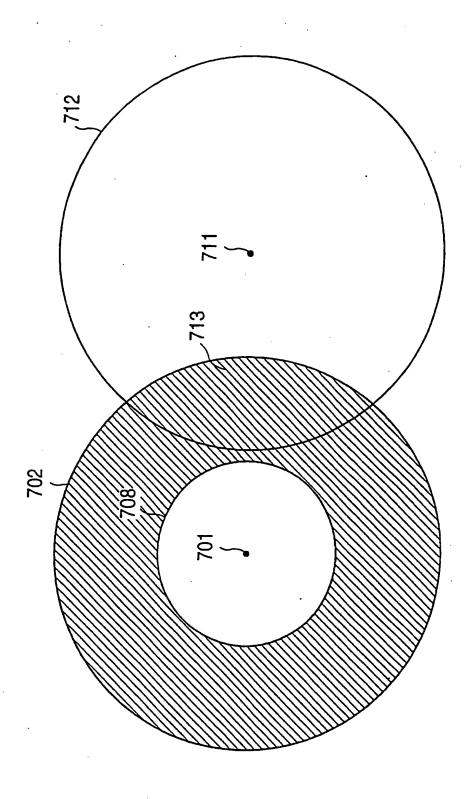


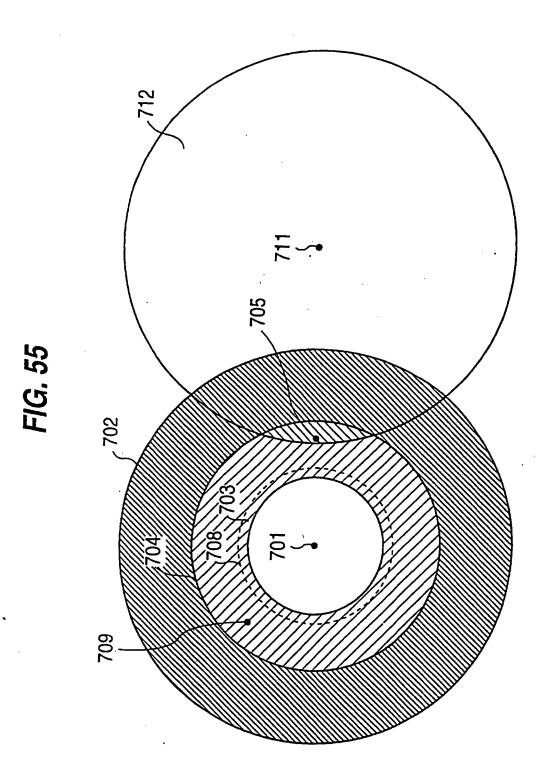












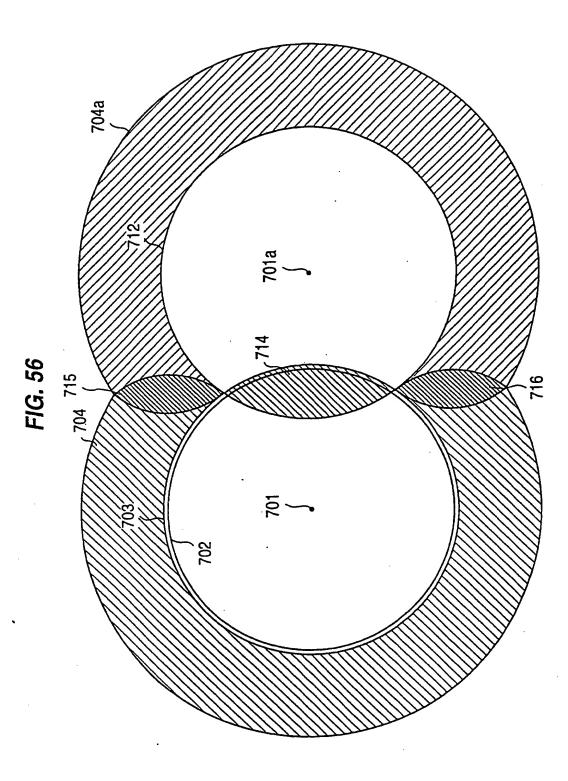


FIG. 57

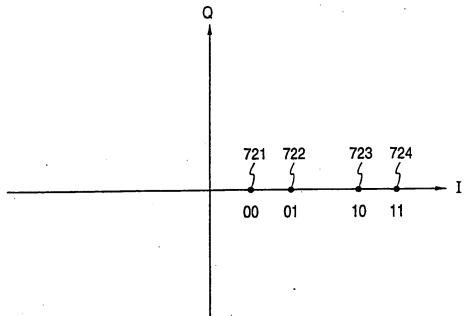
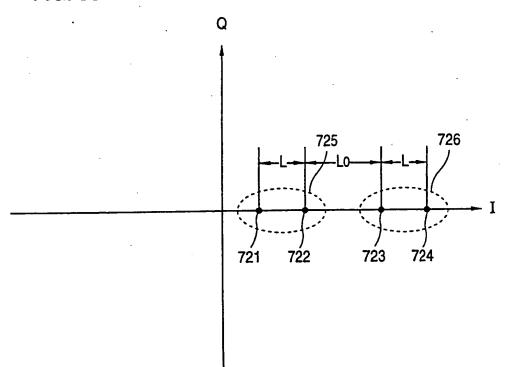
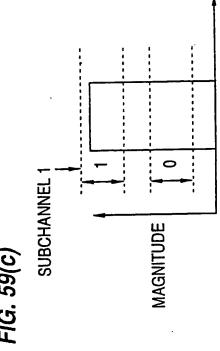
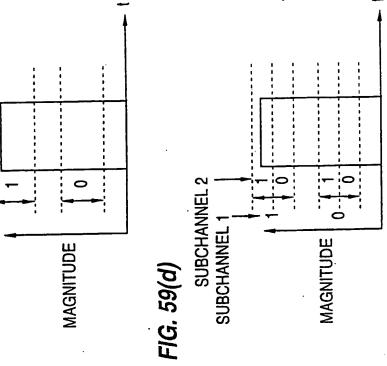
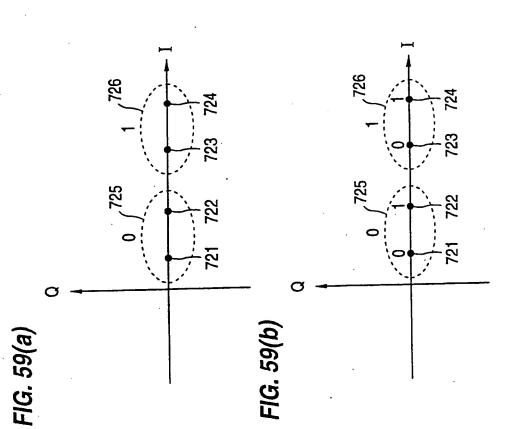


FIG. 58

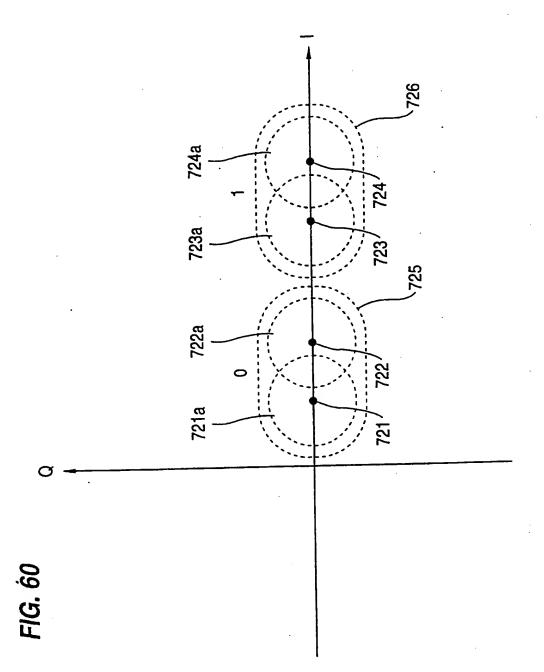


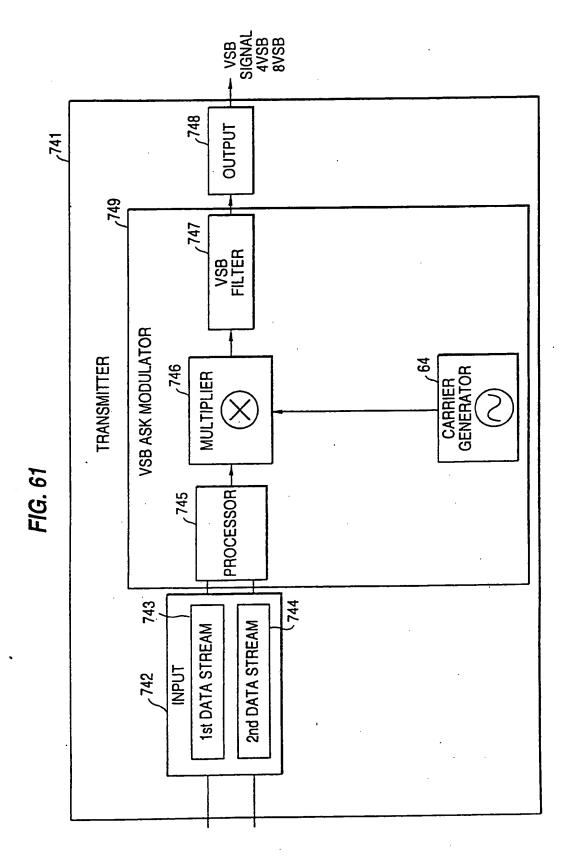


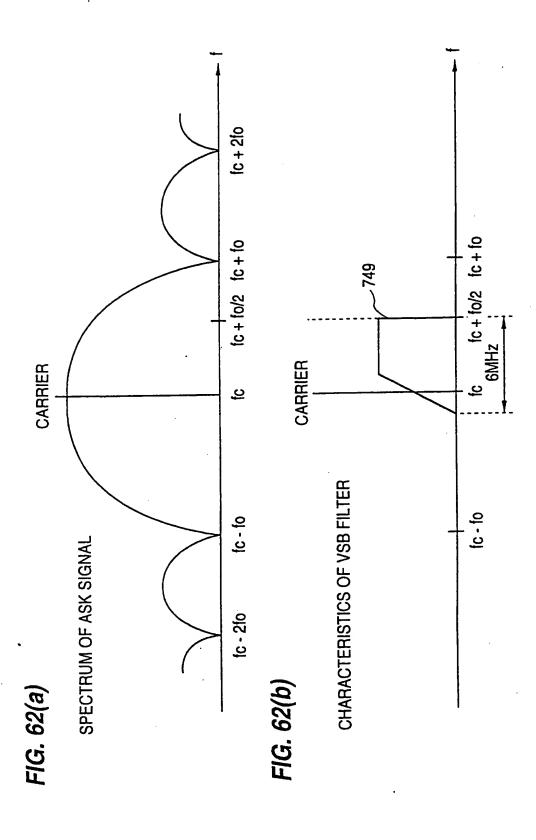


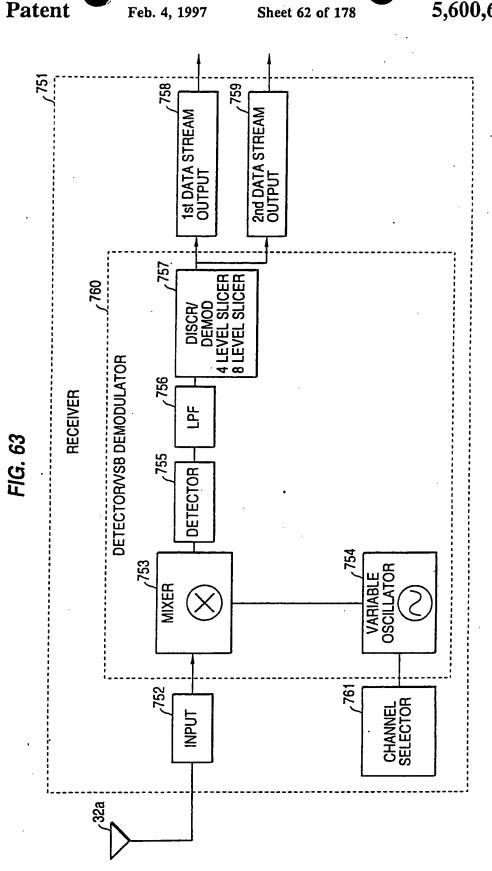






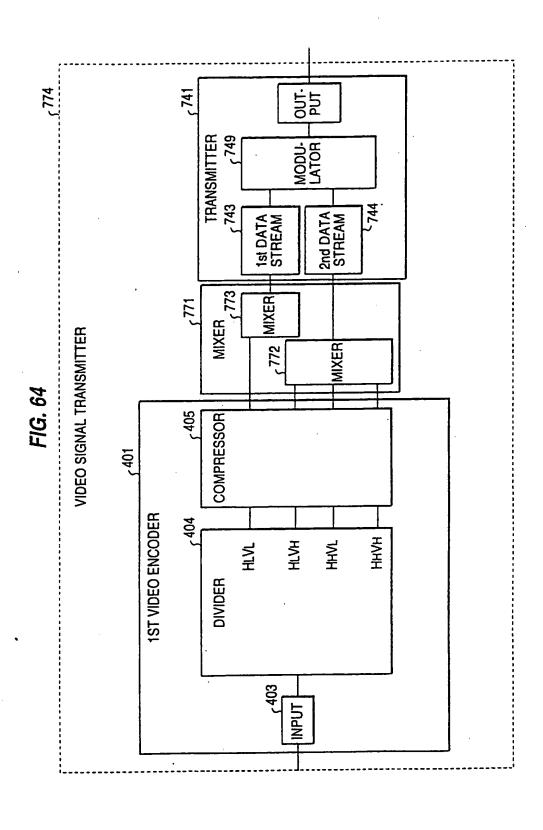


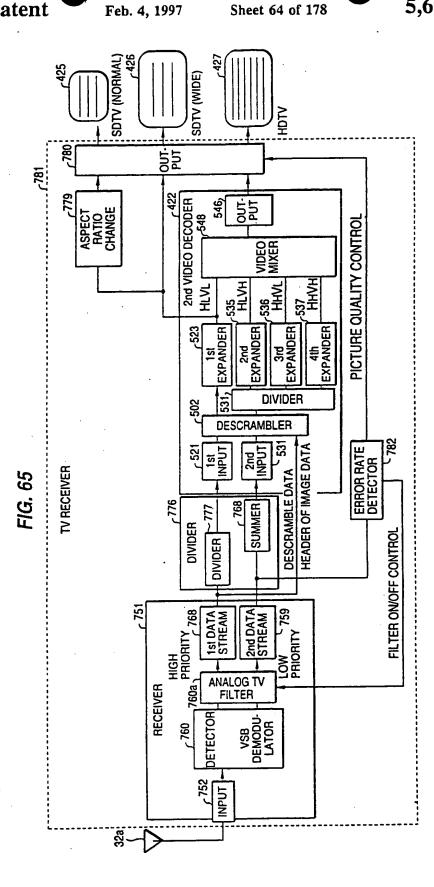




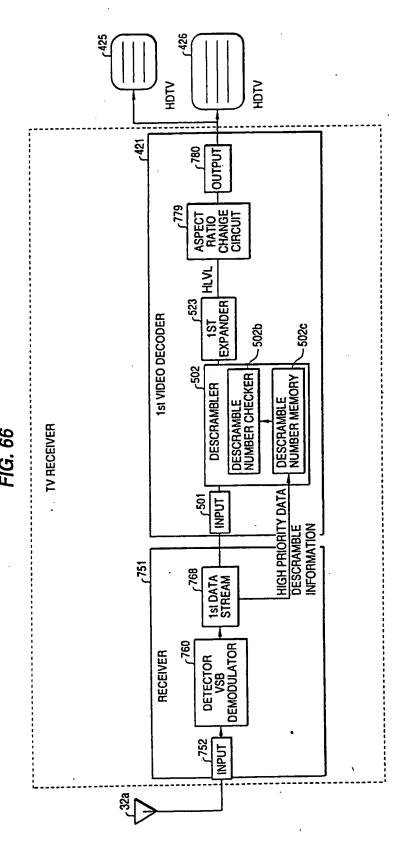
U.S. Patent

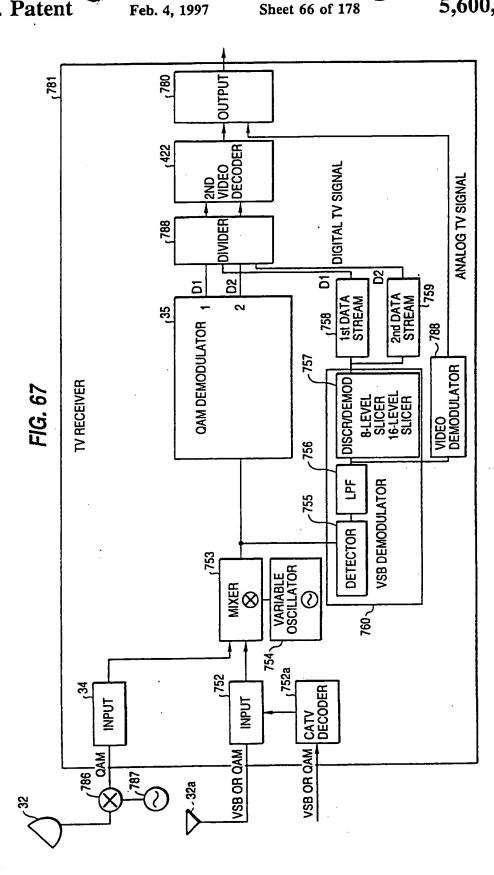




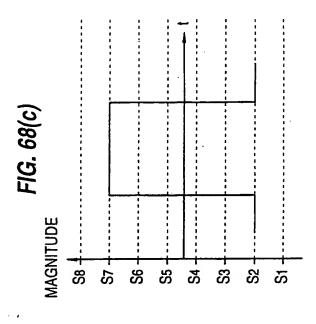


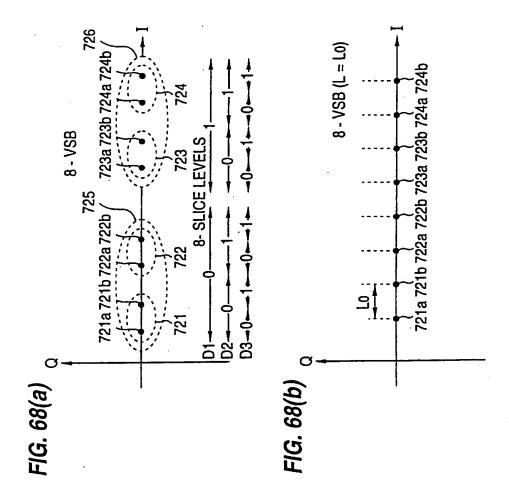
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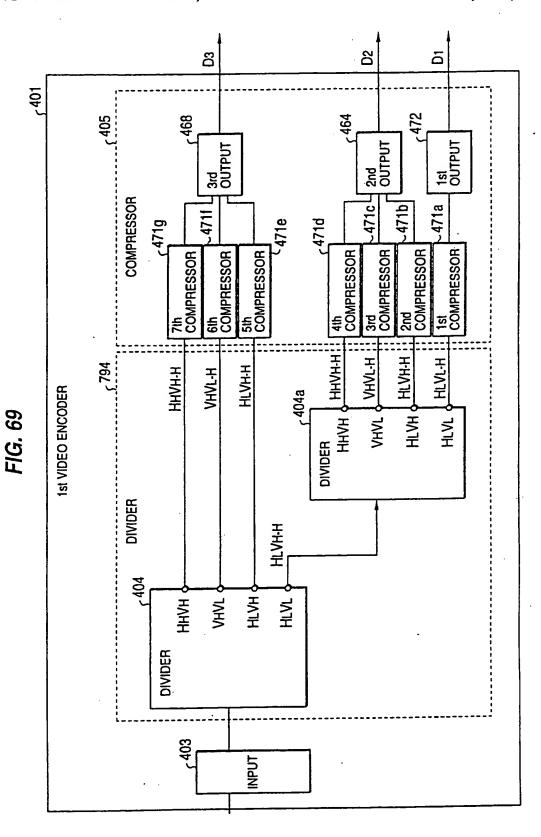


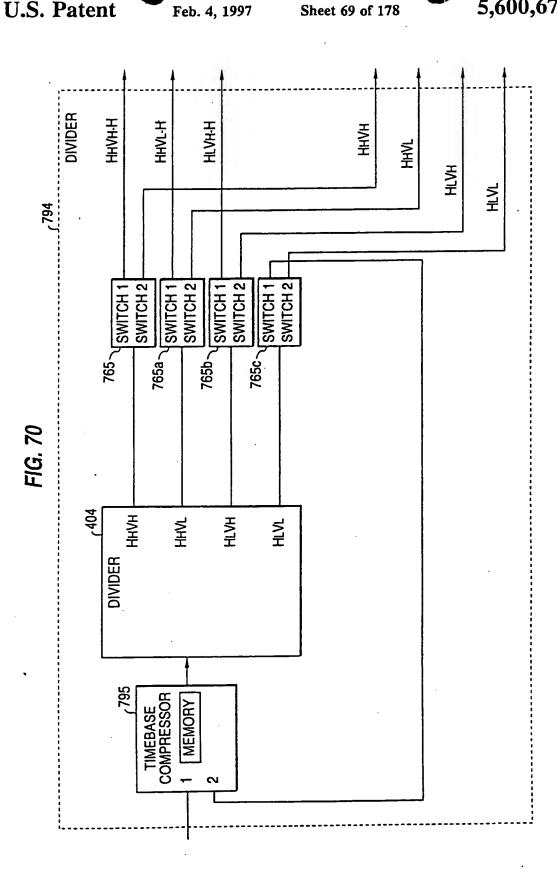


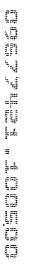
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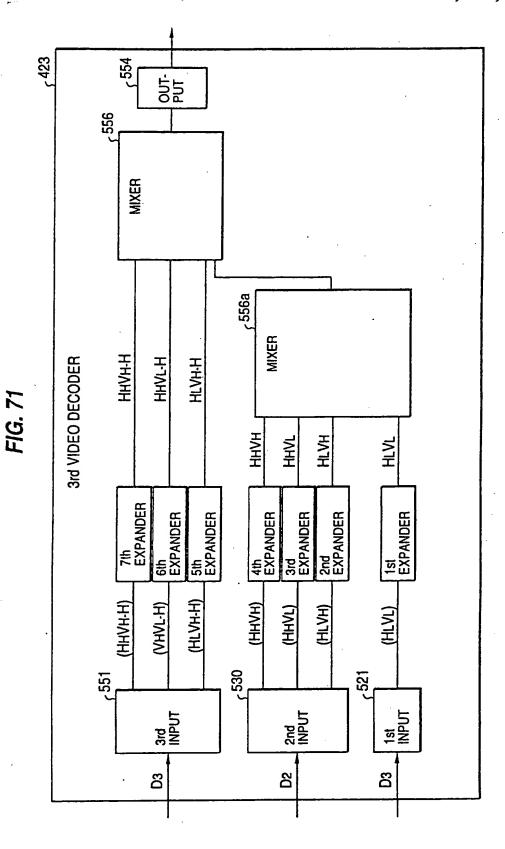












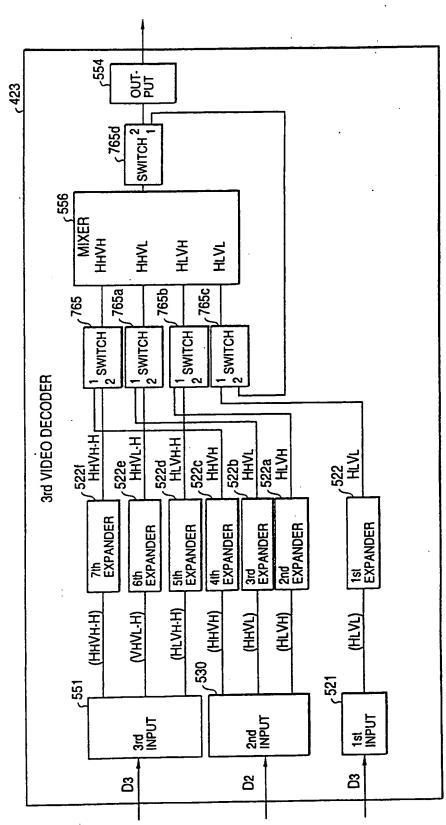
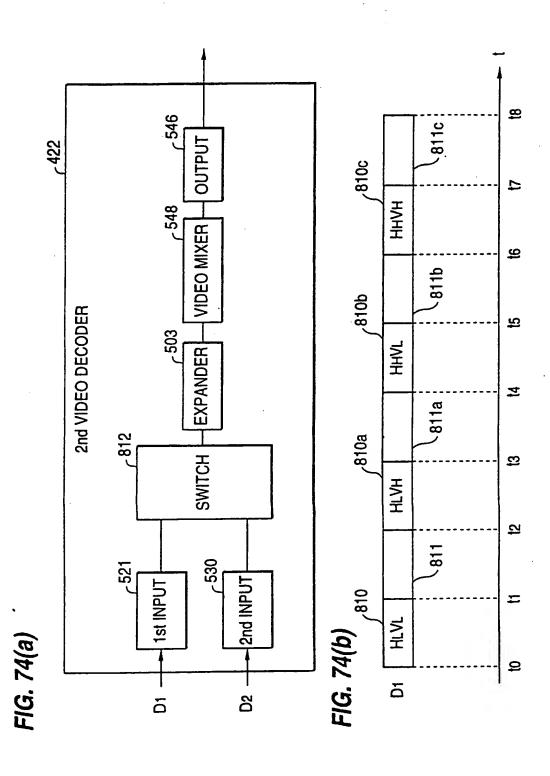


FIG. 72

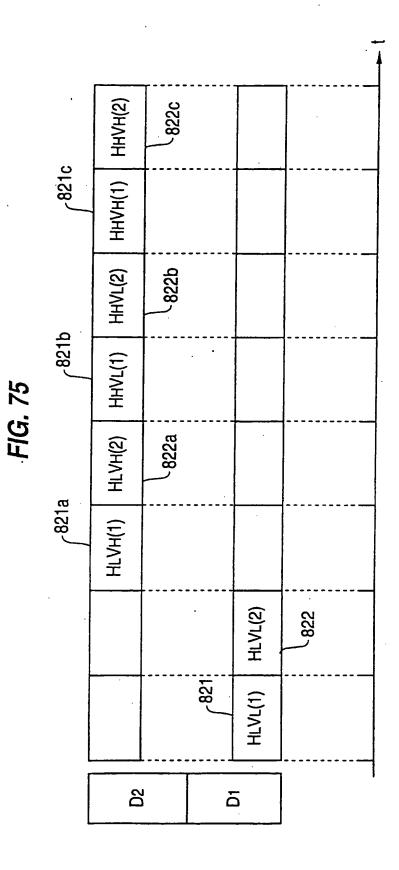
FIG. 73

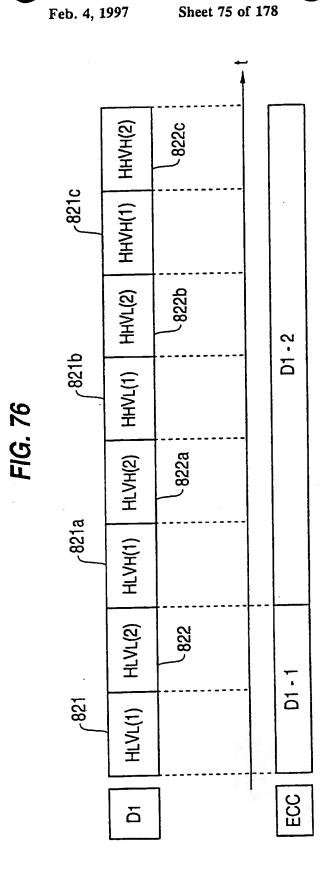
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		HLVL HLVH HHVL HHVH			Ŧ
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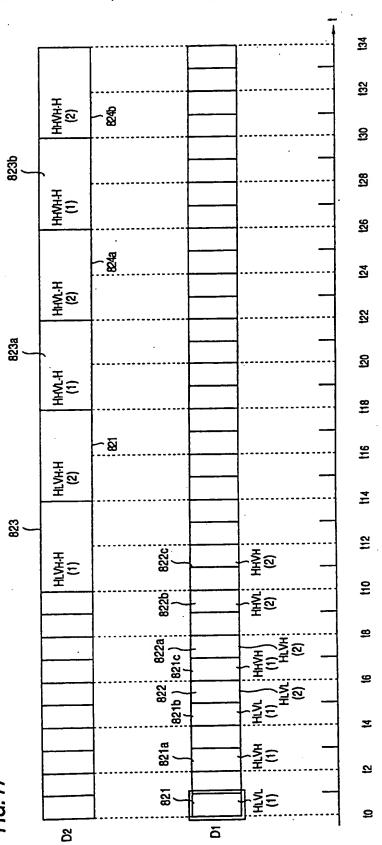


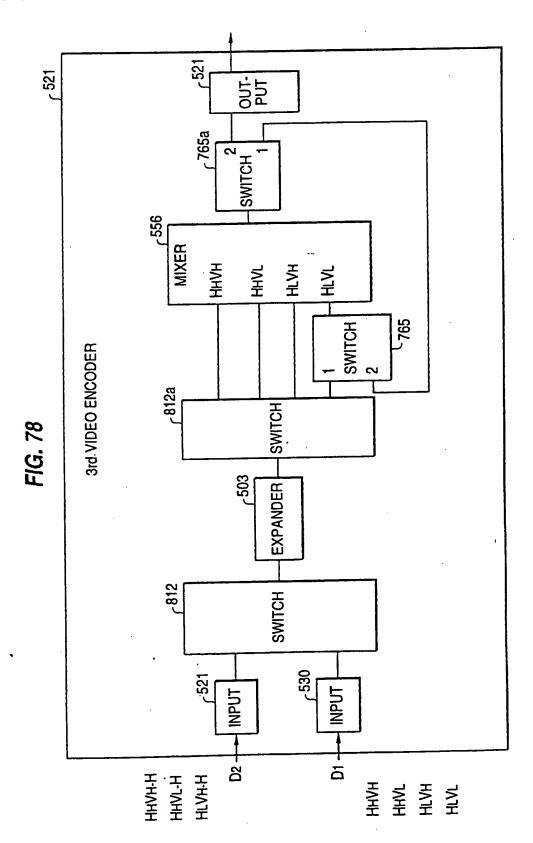


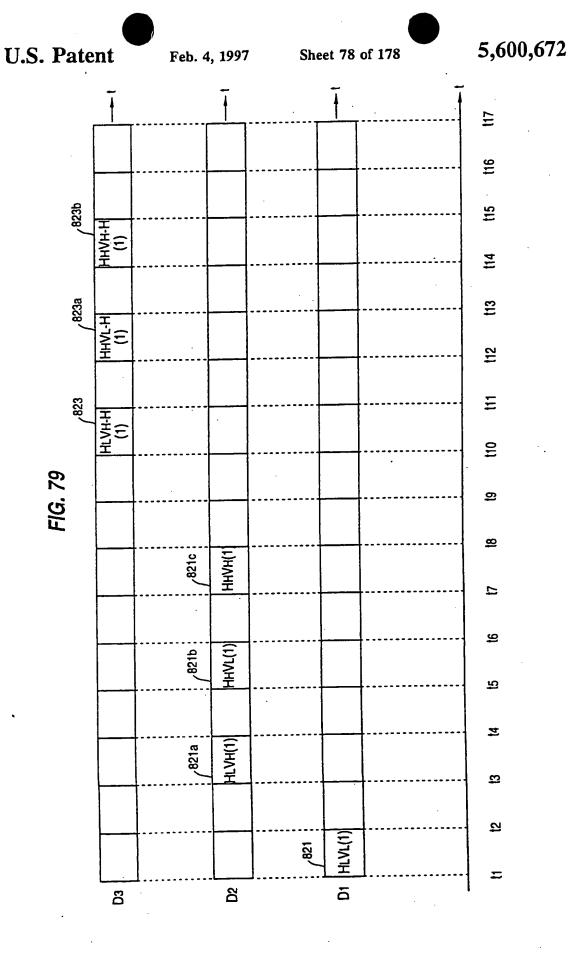


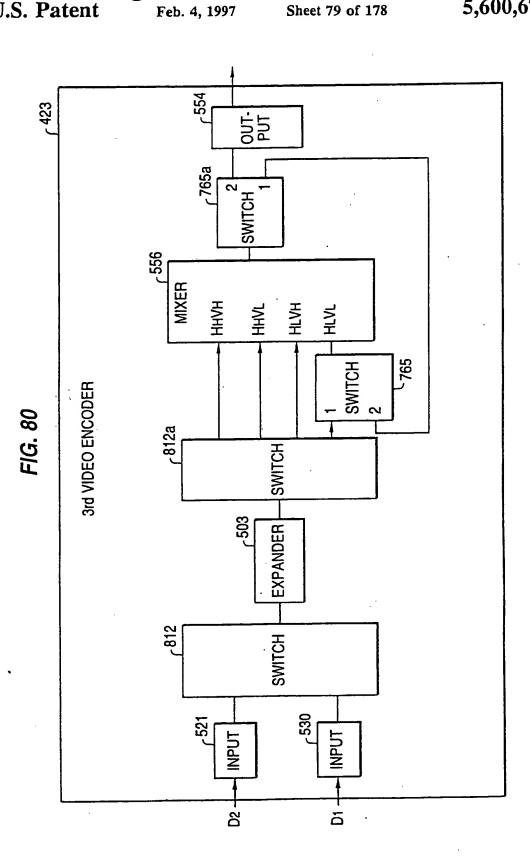












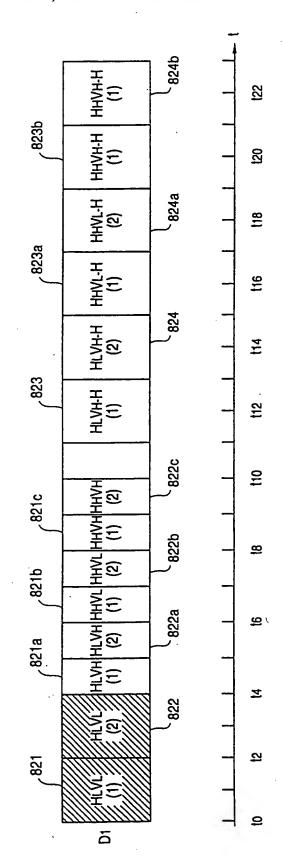
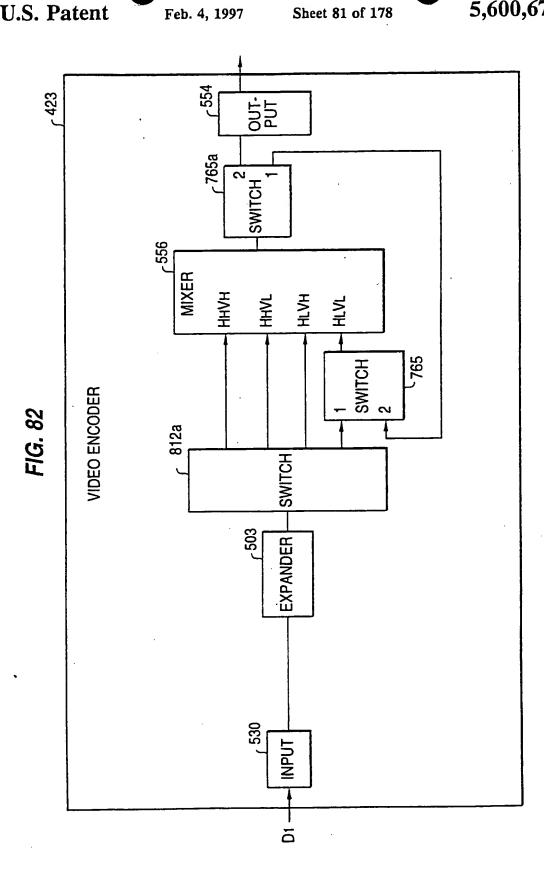
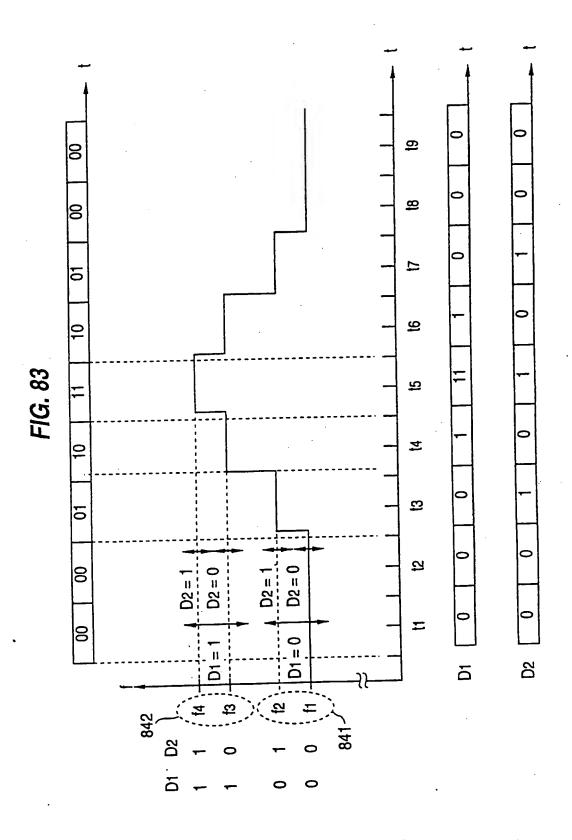


FIG. 81





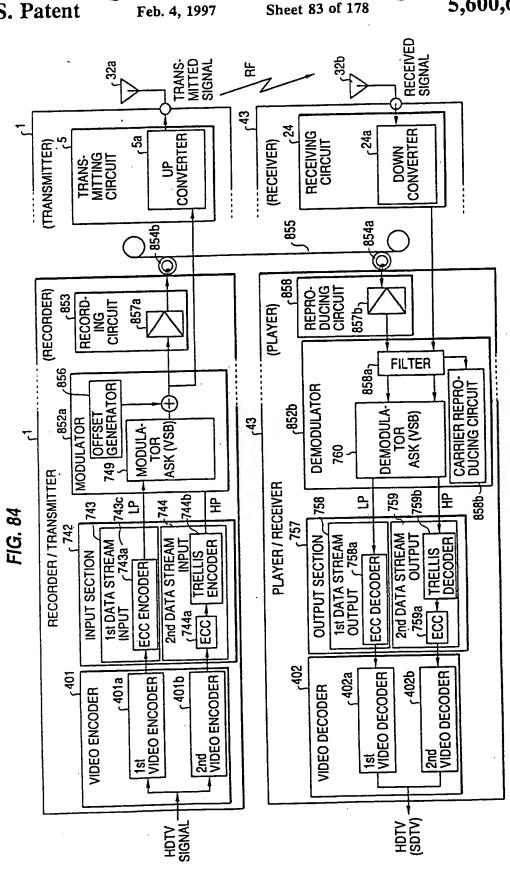
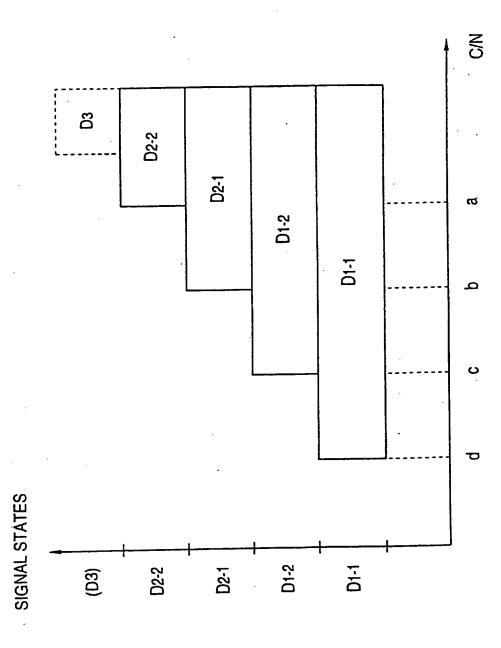
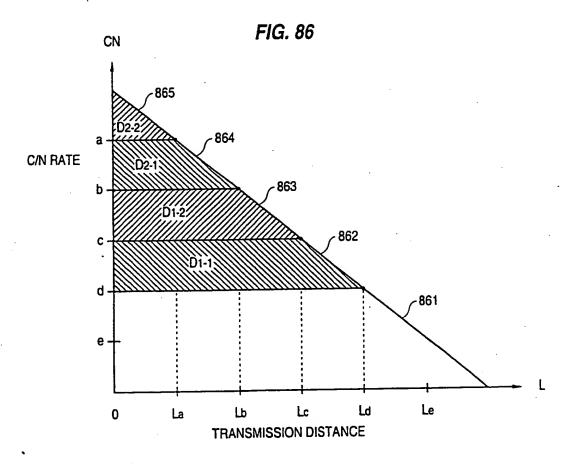
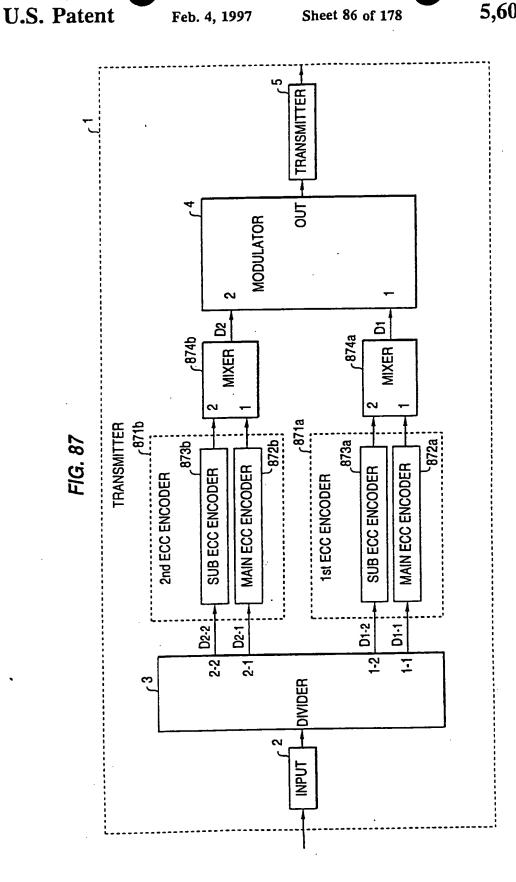


FIG. 85







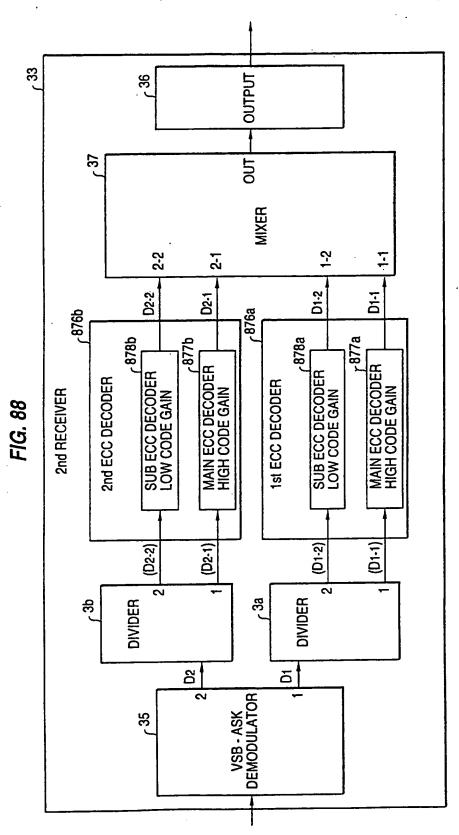
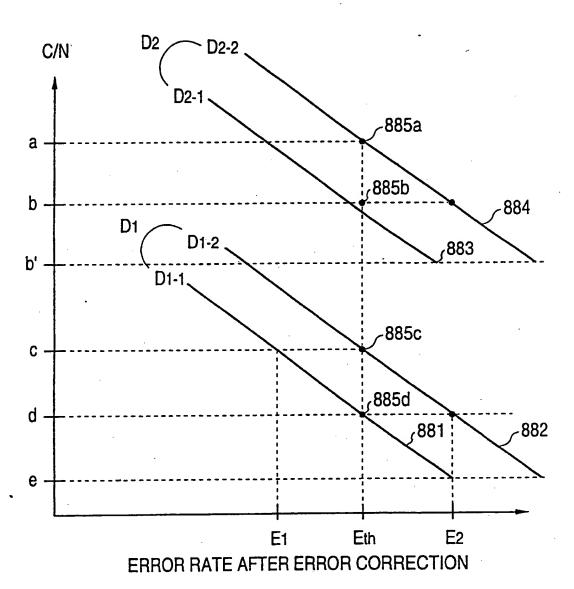
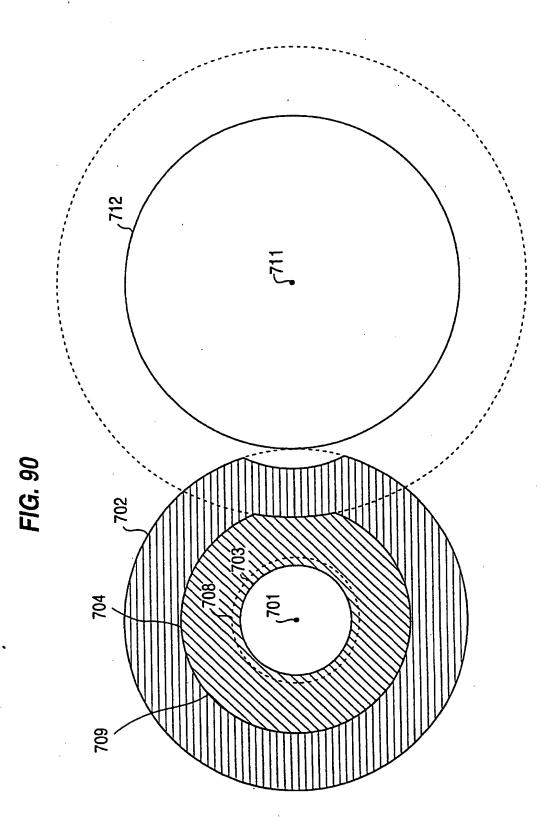


FIG. 89

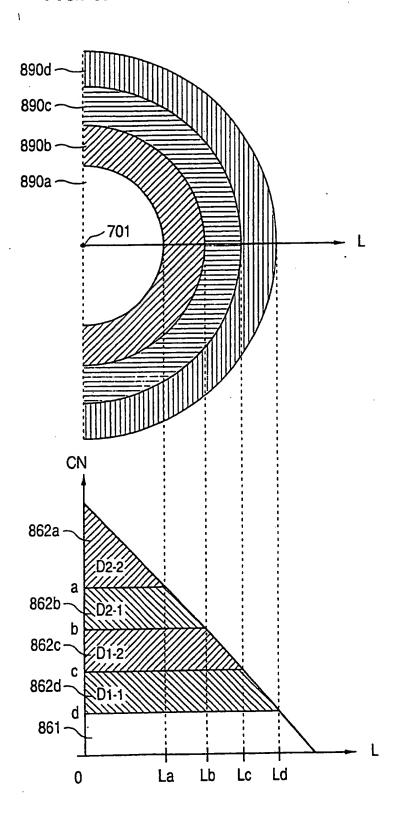


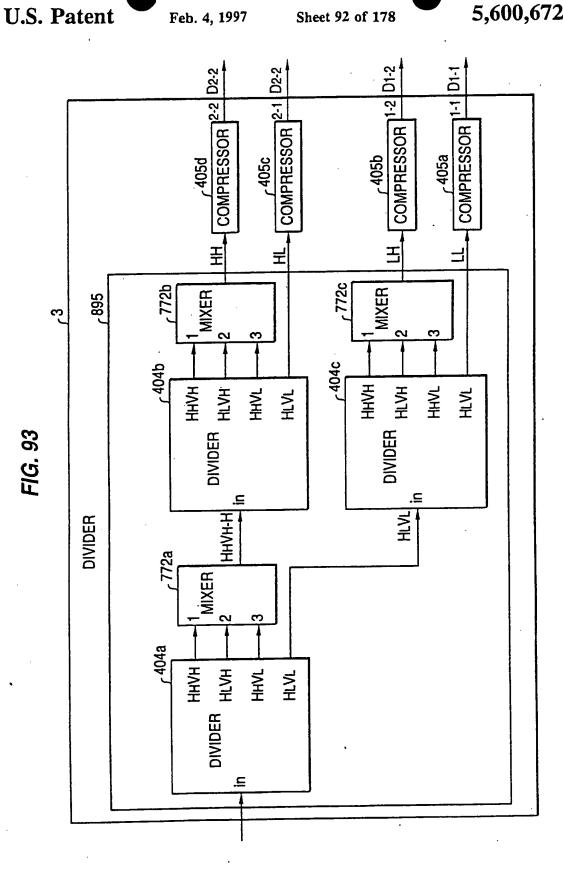


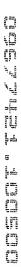


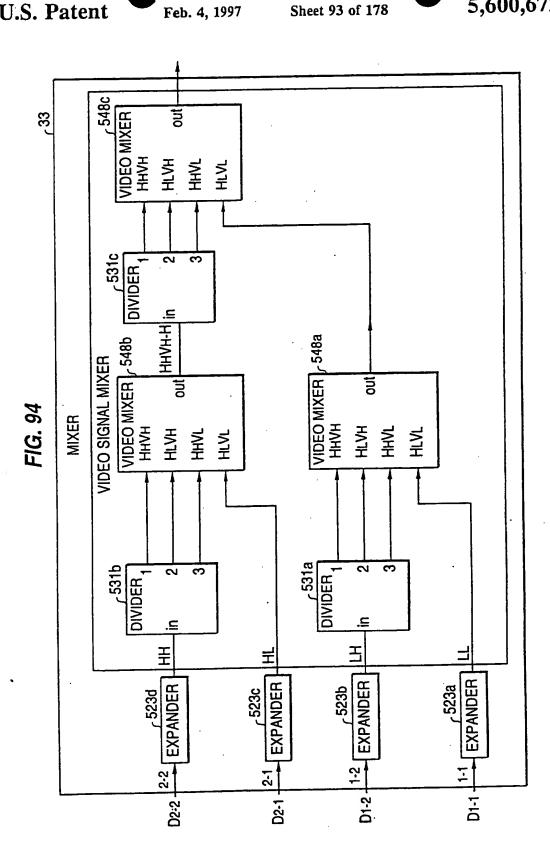
5,600,672 U.S. Patent Feb. 4, 1997 Sheet 90 of 178

FIG. 92



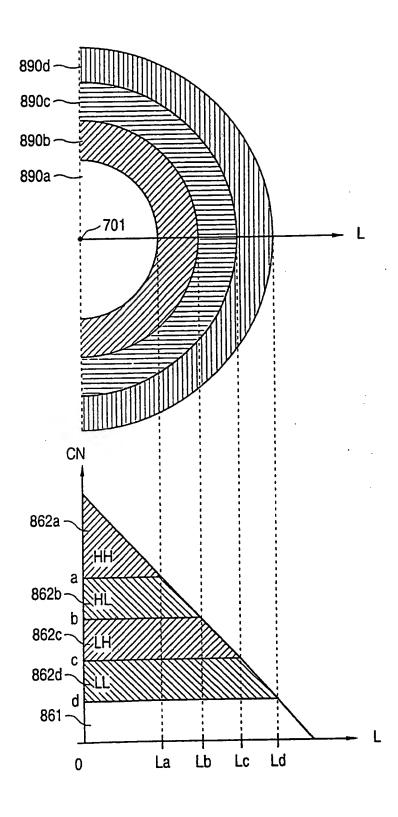




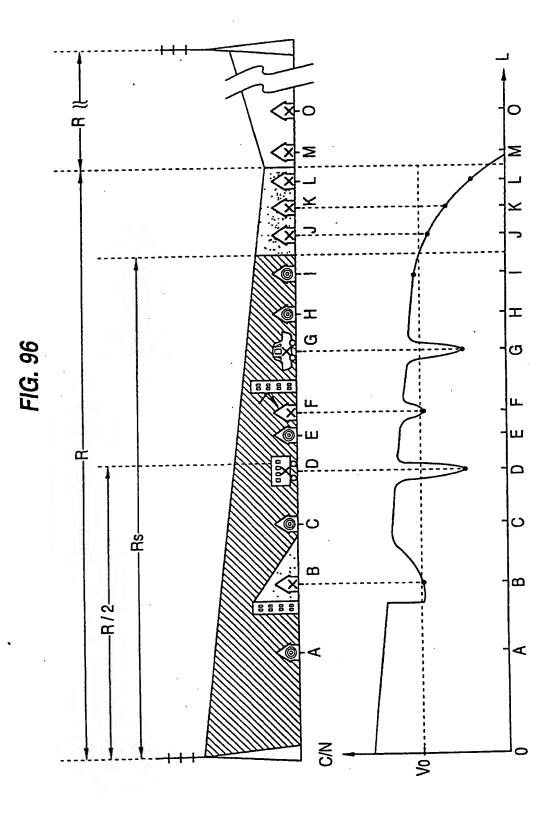


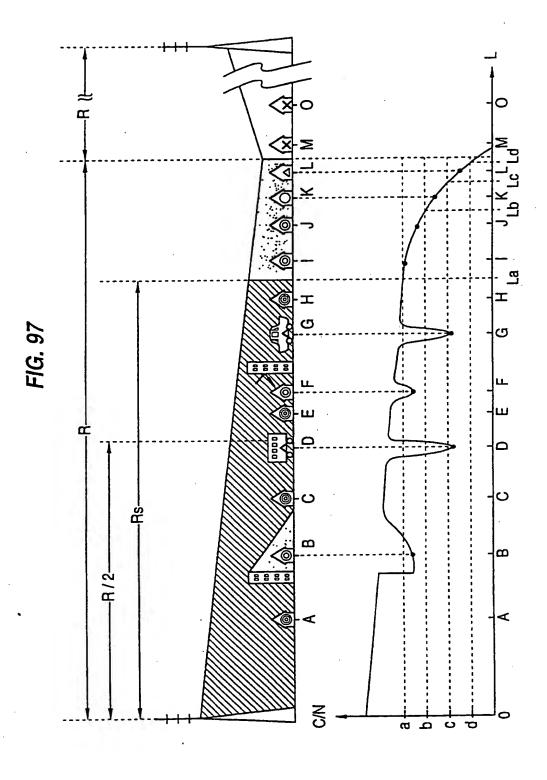
Patent Feb. 4, 1997

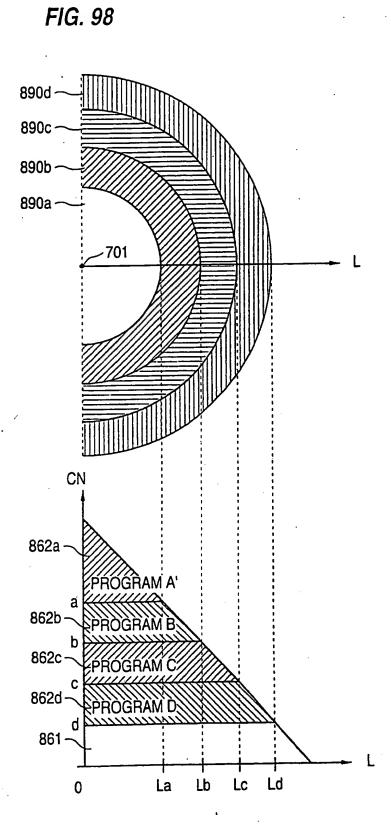
FIG. 95

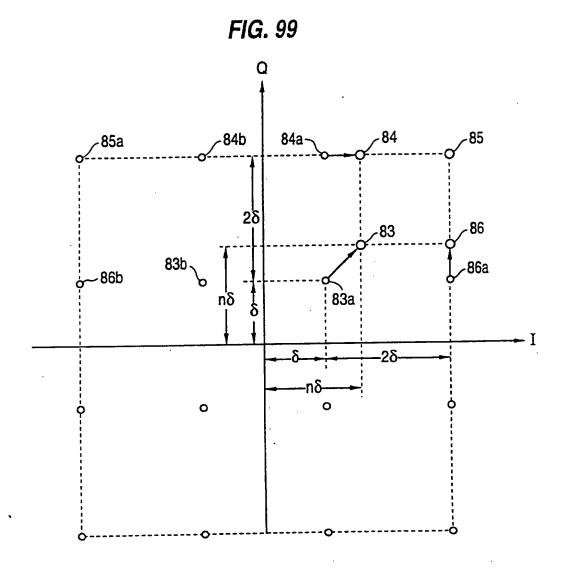


Feb. 4, 1997









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FIG. 100

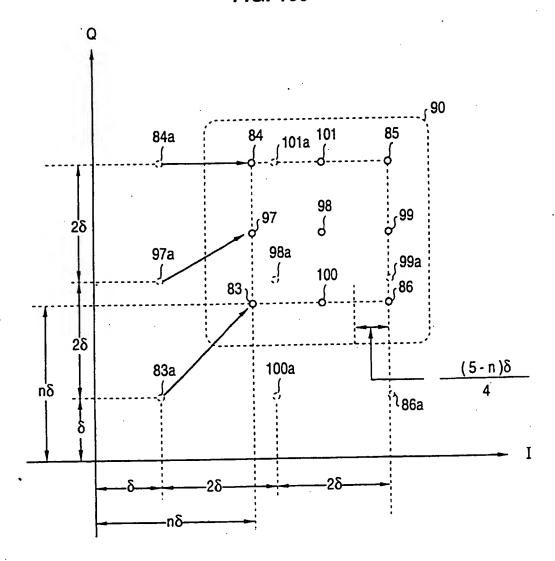
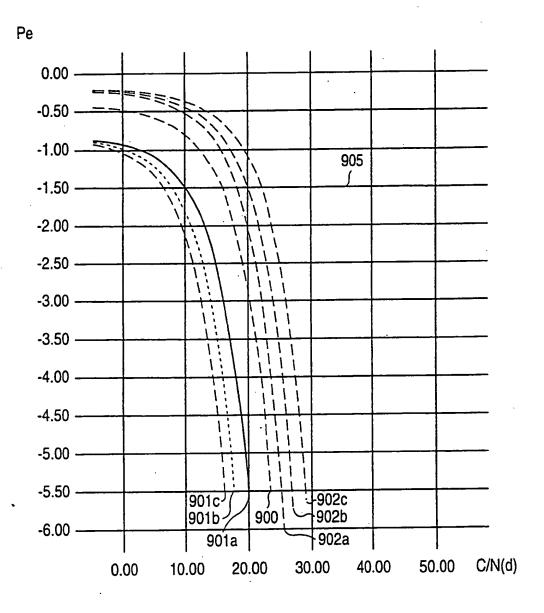


FIG. 101



The Constitution of the little and t The first from the first first that

FIG. 102

Sheet 101 of 178

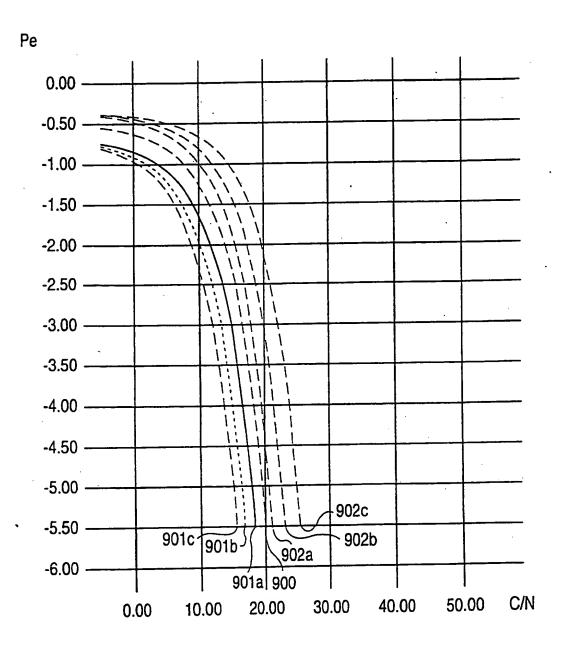


FIG. 103

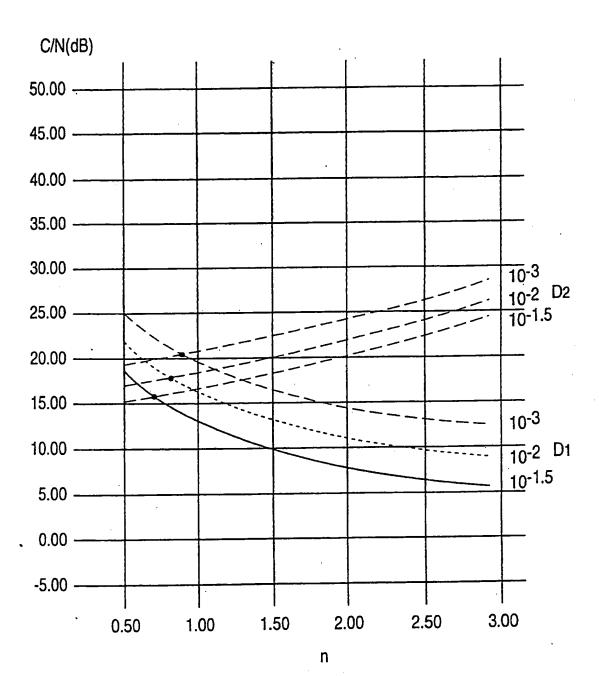
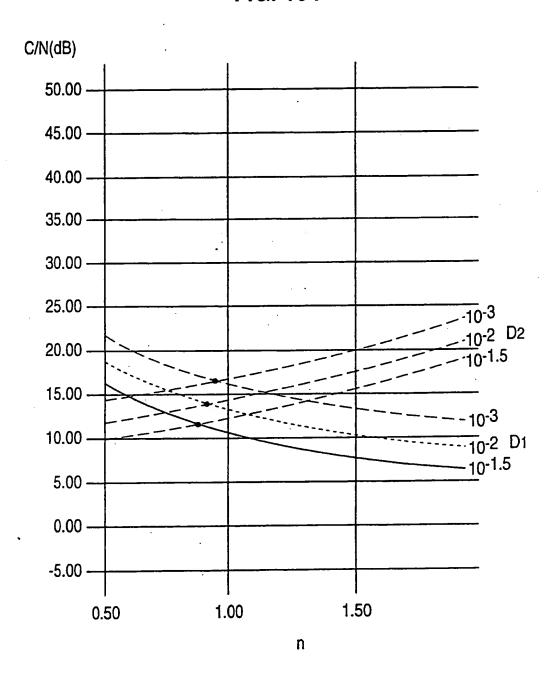
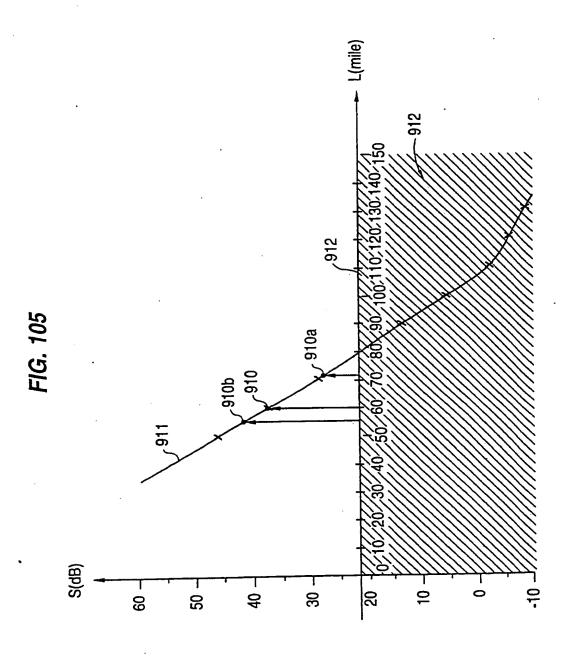


FIG. 104

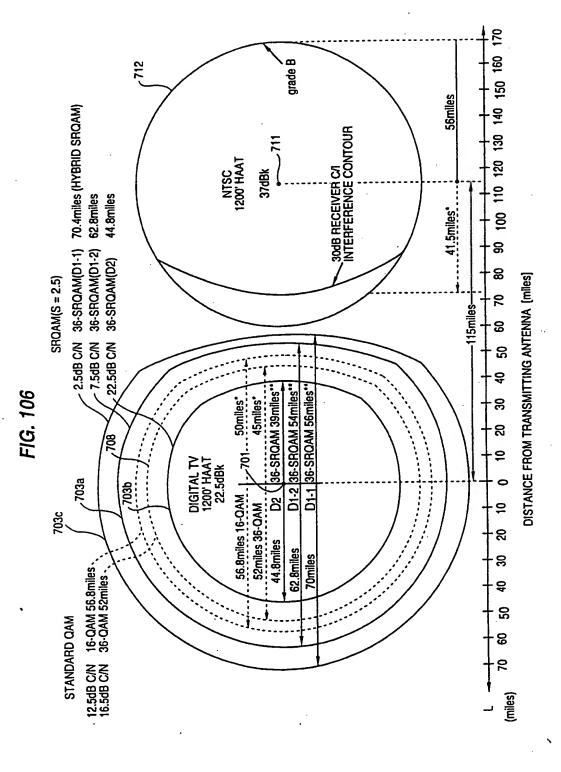
Sheet 103 of 178

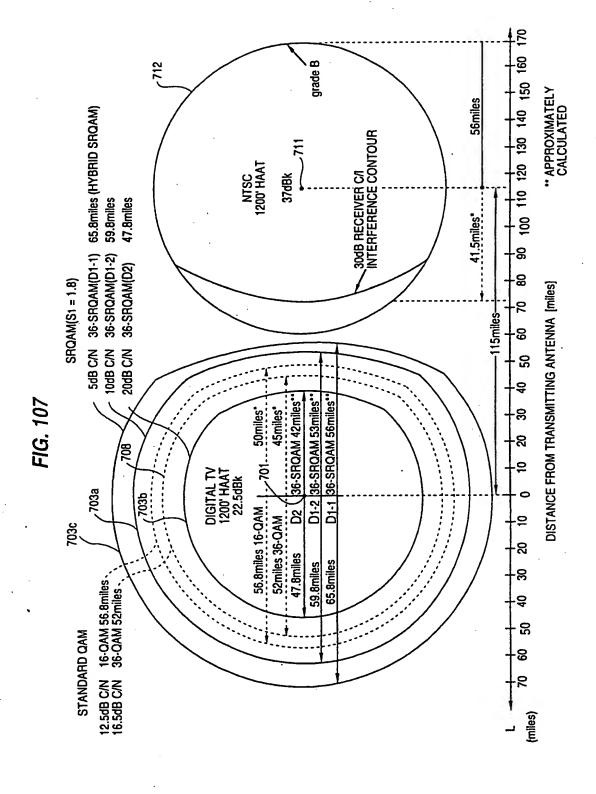




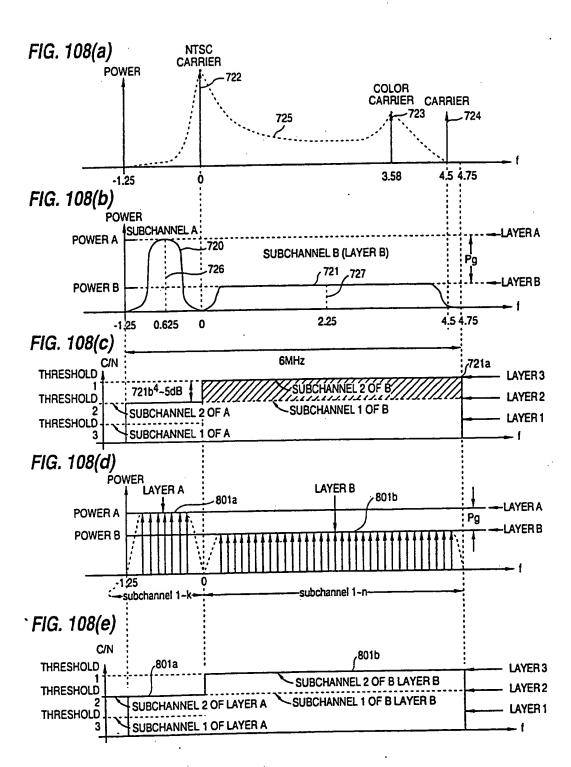


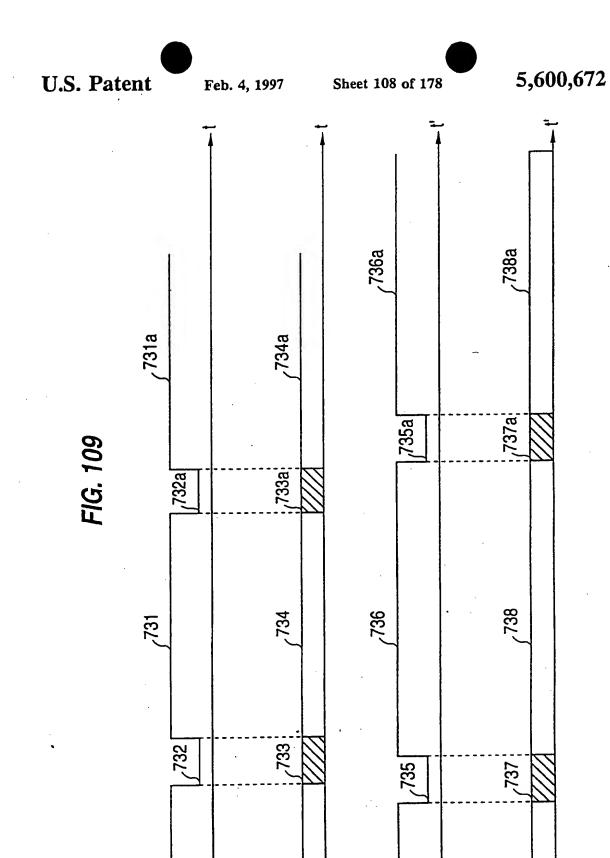
Feb. 4, 1997





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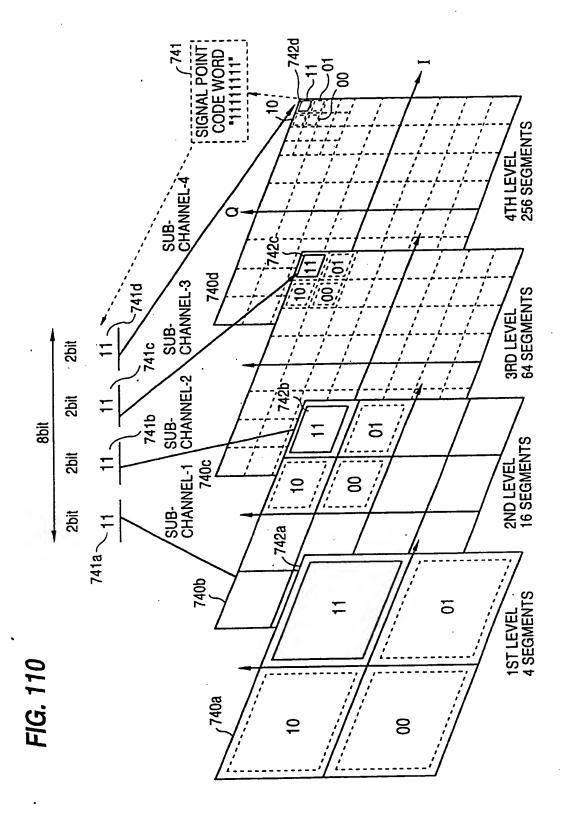


FIG. 111

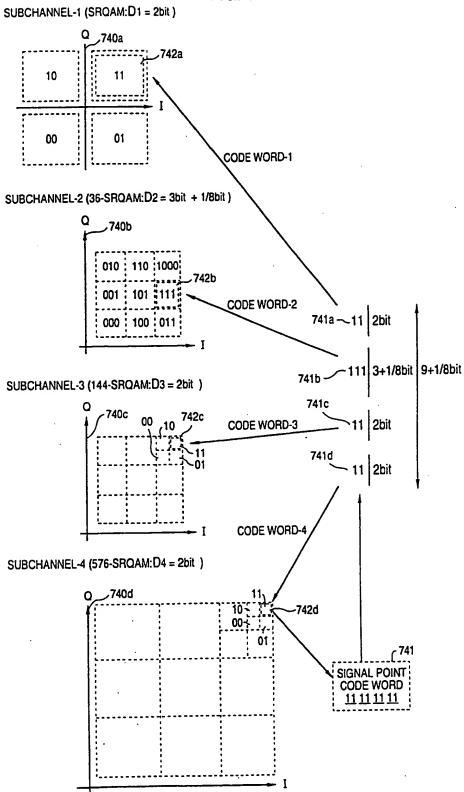
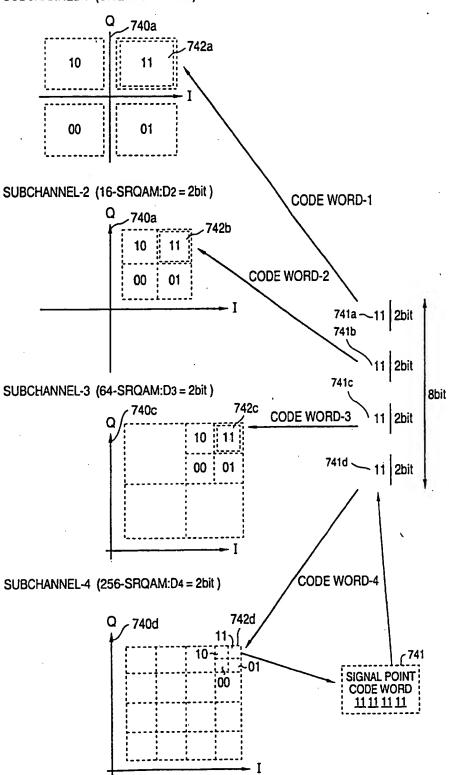
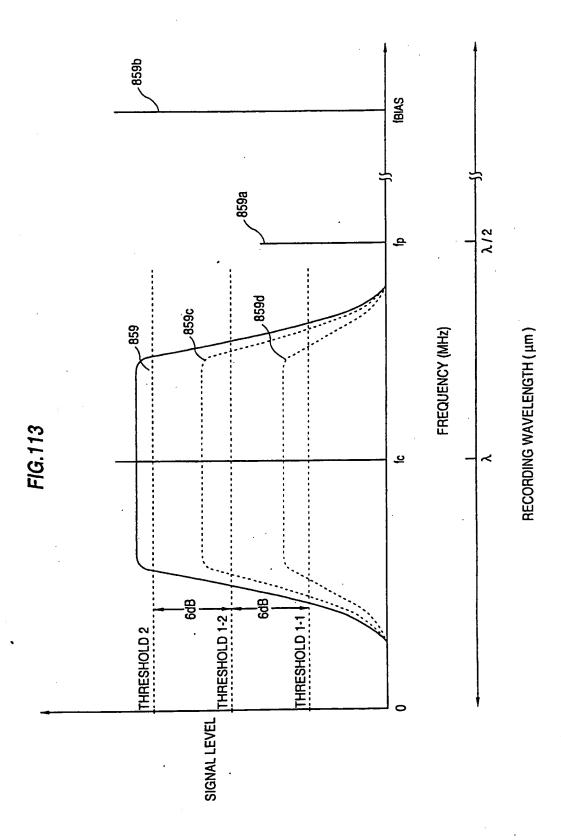


FIG. 112

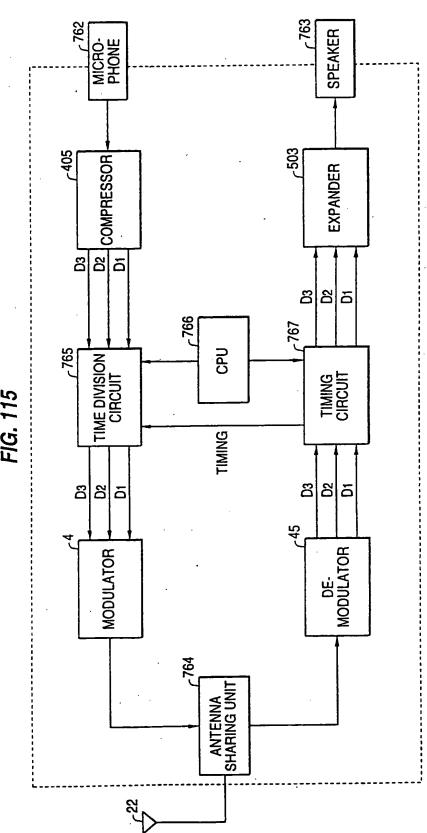
SUBCHANNEL-1 (SRQAM:D1 = 2bit)



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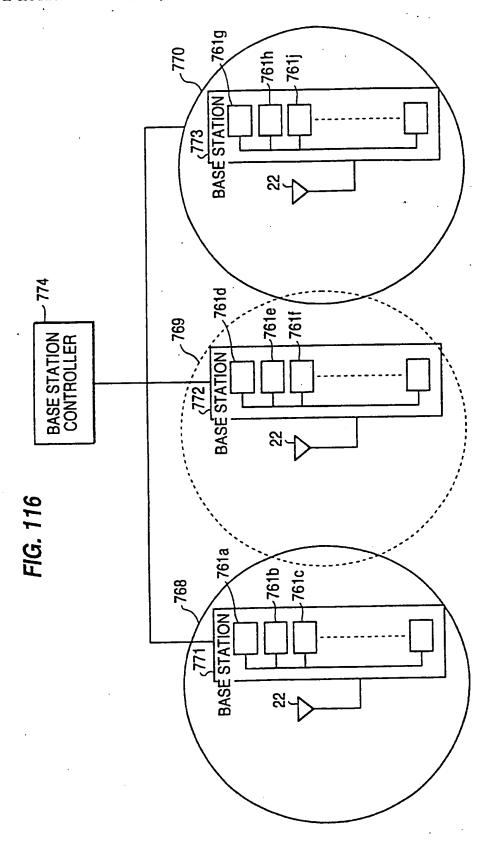
5,600,672 U.S. Patent Sheet 113 of 178 Feb. 4, 1997 851 RECORDING PLAYBACK CARRIER REPRODUCTION BIAS GENERATOR FILTER 858b 160 201 CARRIER MODULATOR /DEMODULATOR DE. MODULATOR MODULATOR ပြ MAGNETIC RECORDING / PLAYBACK APPARATUS FIG. 114 5 5 OUTPUT SECTION , 758 1ST DATA STREAM OUTPUT 1ST DATA STREAM INPUT INPUT SECTION 742 422a 401a 422 1ST VIDEO DECODER 1ST VIDEO ENCODER VIDEO DECODER **VIDEO ENCODER**

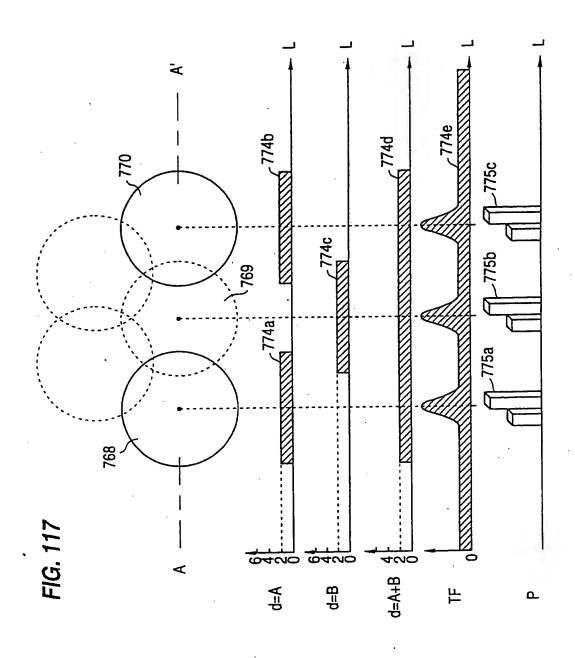


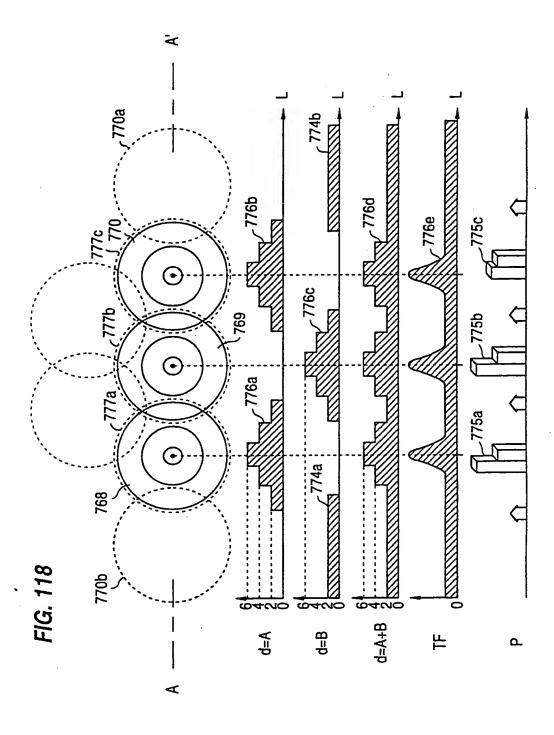
Feb. 4, 1997

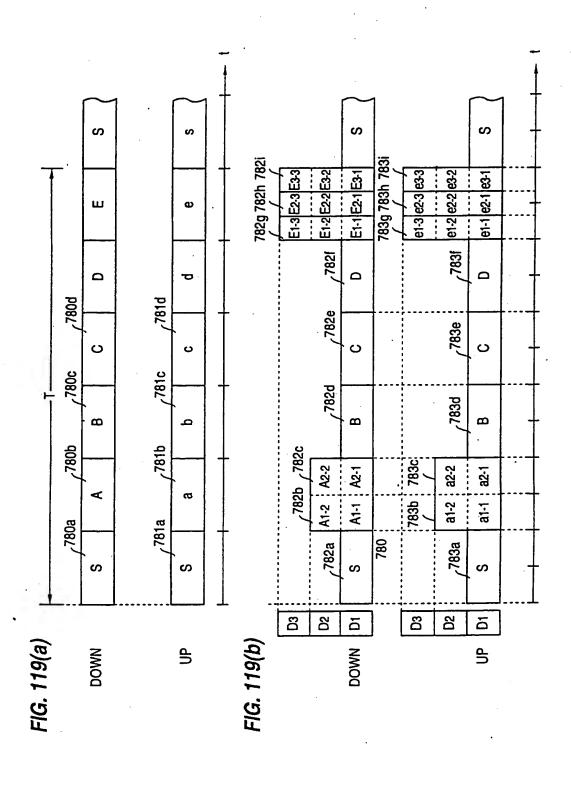
Sheet 115 of 178

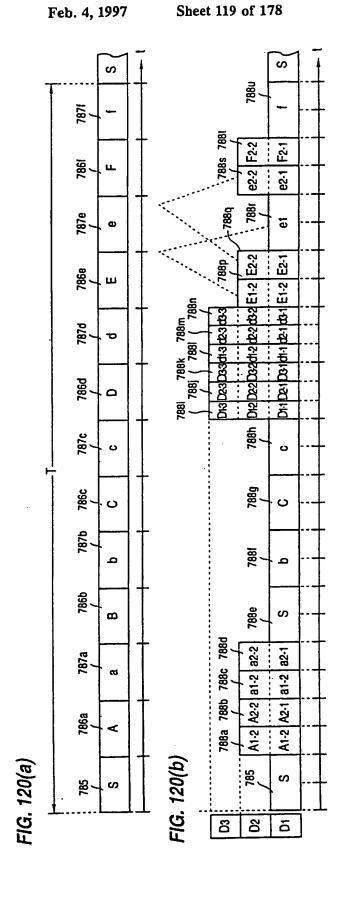
5,600,672



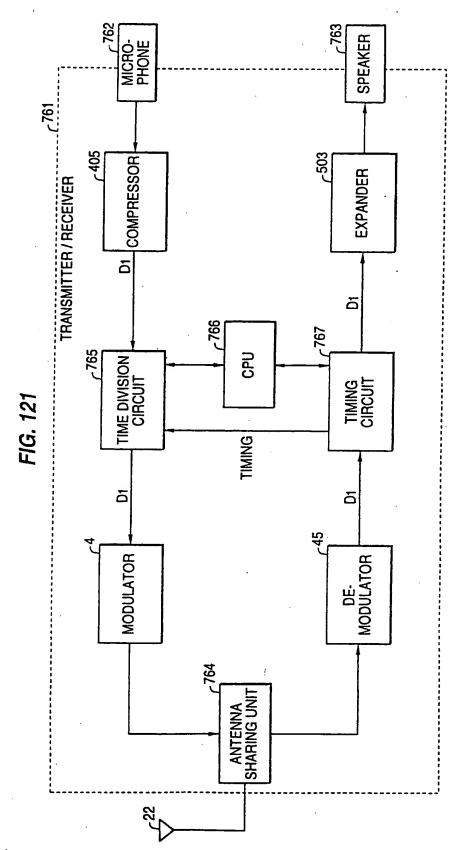


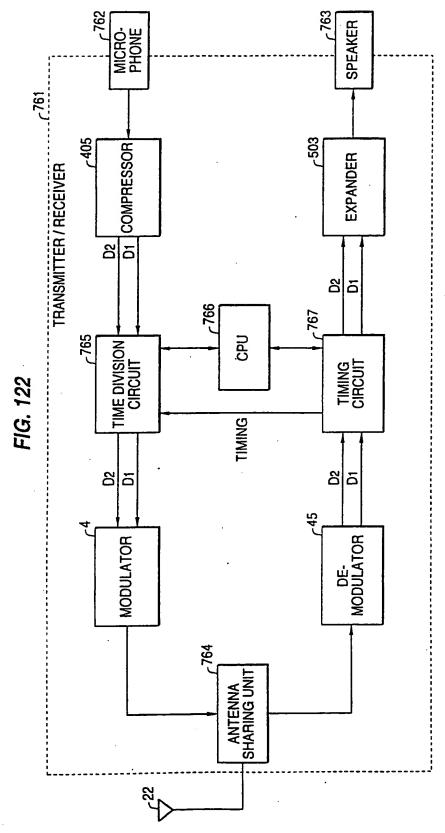






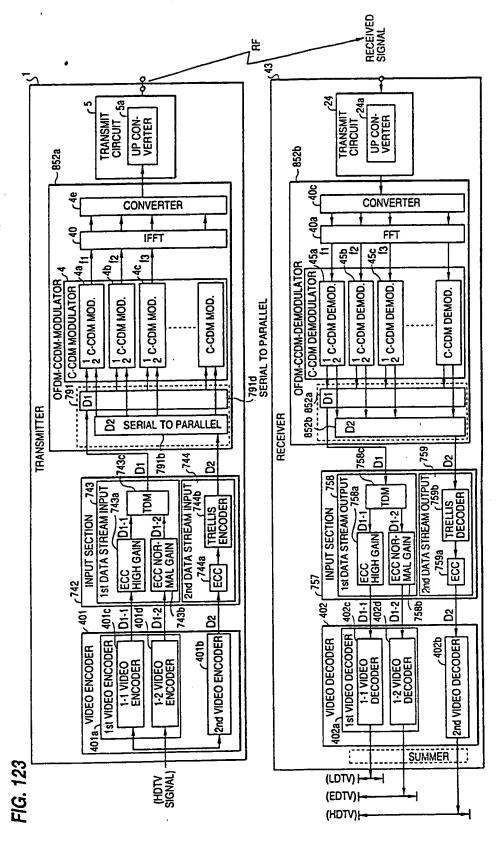
U.S. Patent Feb. 4, 1997 Sheet 120 of 178 5,600,672

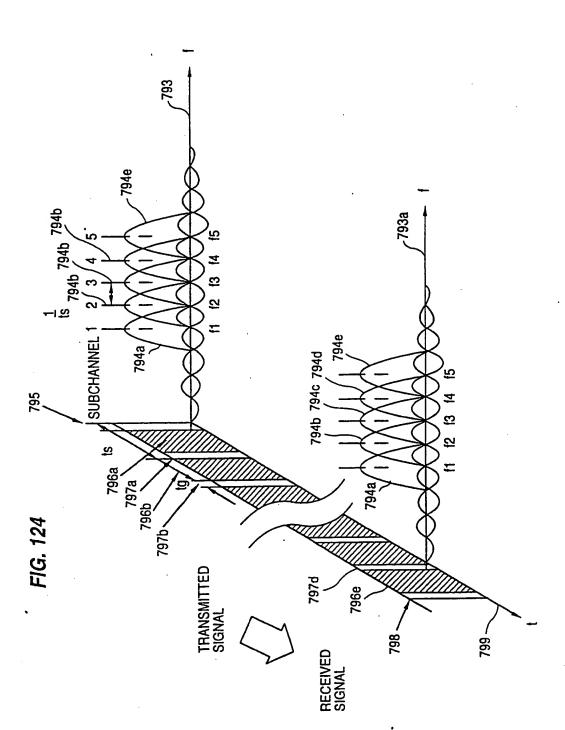


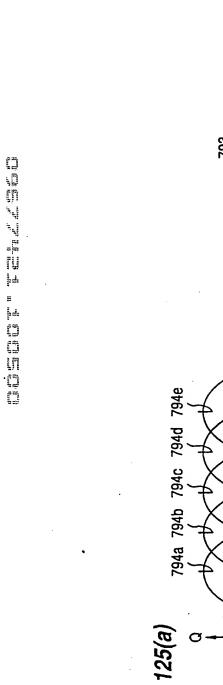


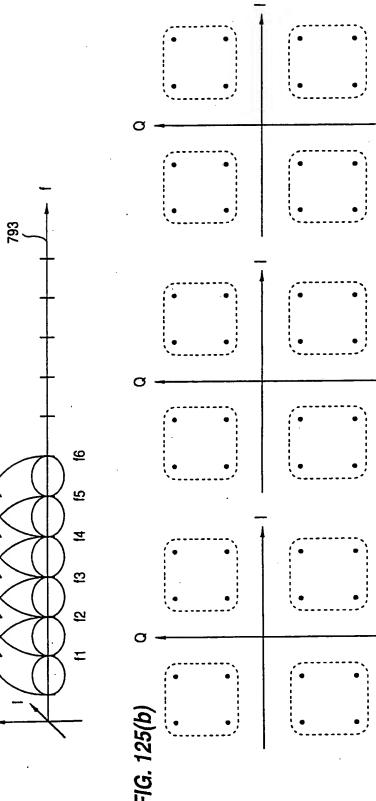
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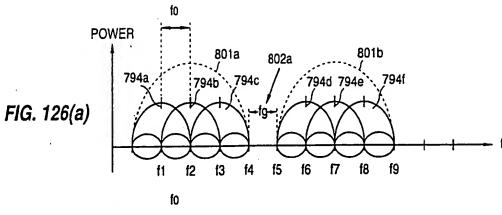
Sheet 122 of 178

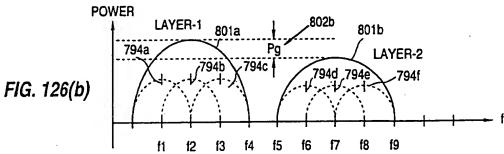


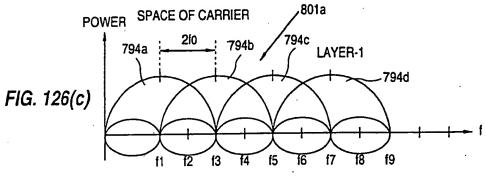


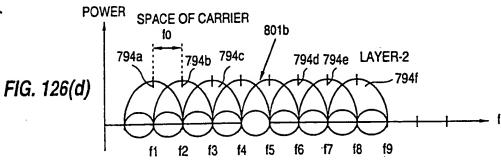












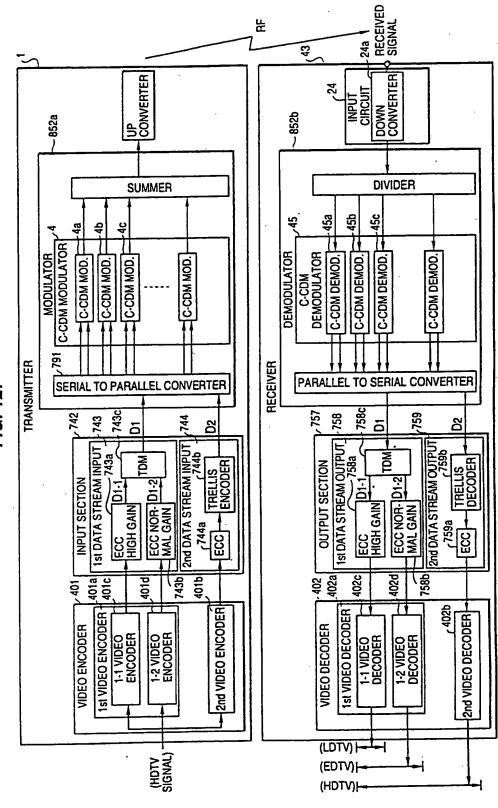


FIG. 127

FIG. 128(a)

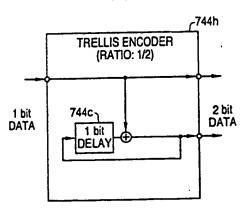


FIG. 128(d)

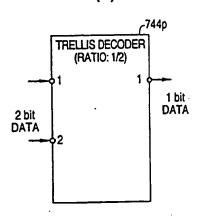


FIG. 128(b)

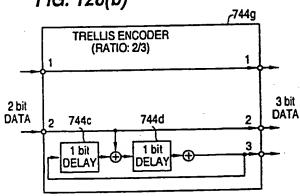


FIG. 128(e)

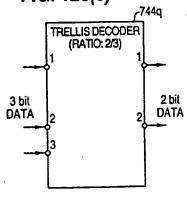


FIG. 128(c)

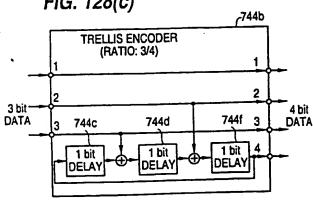
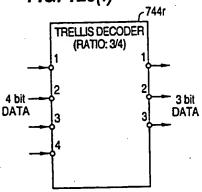
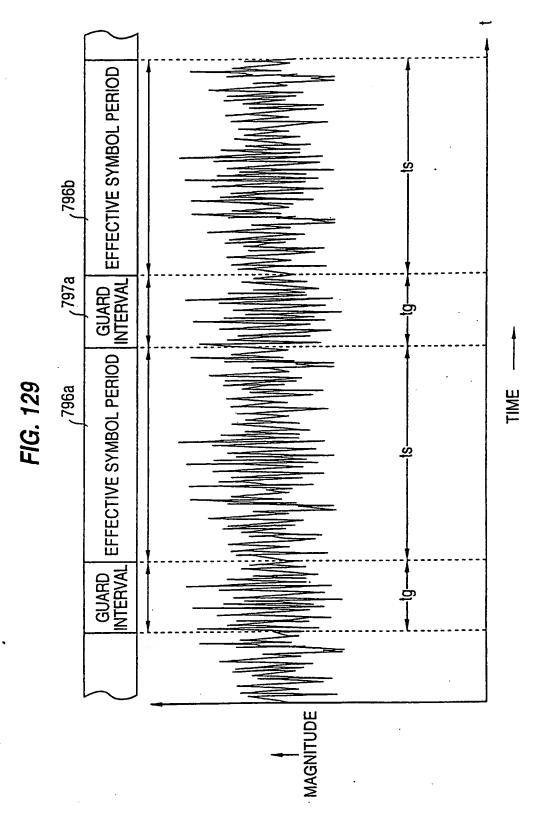
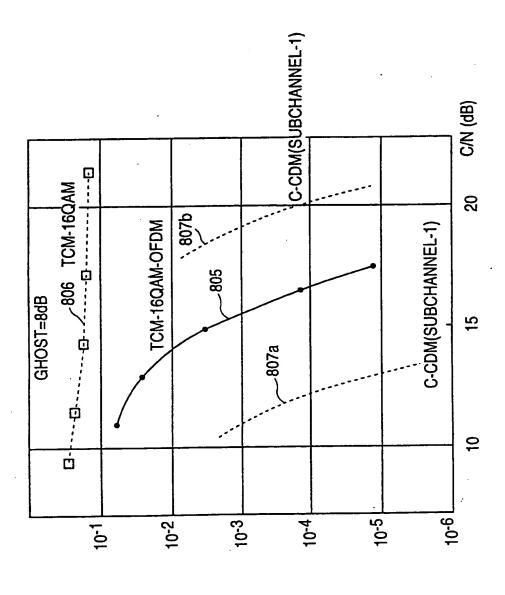


FIG. 128(f)









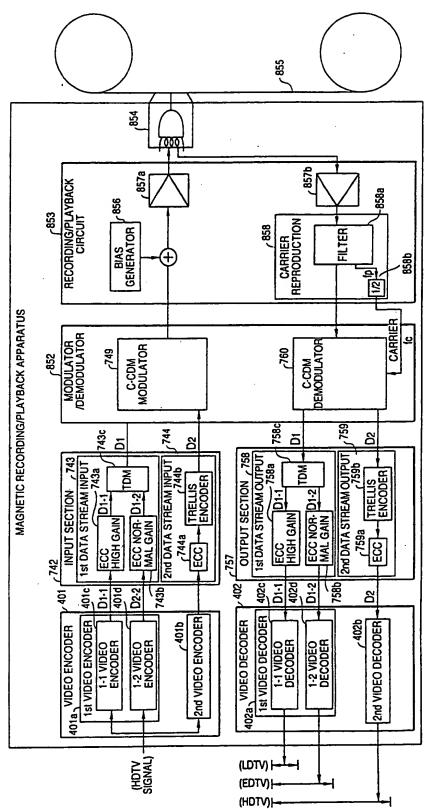
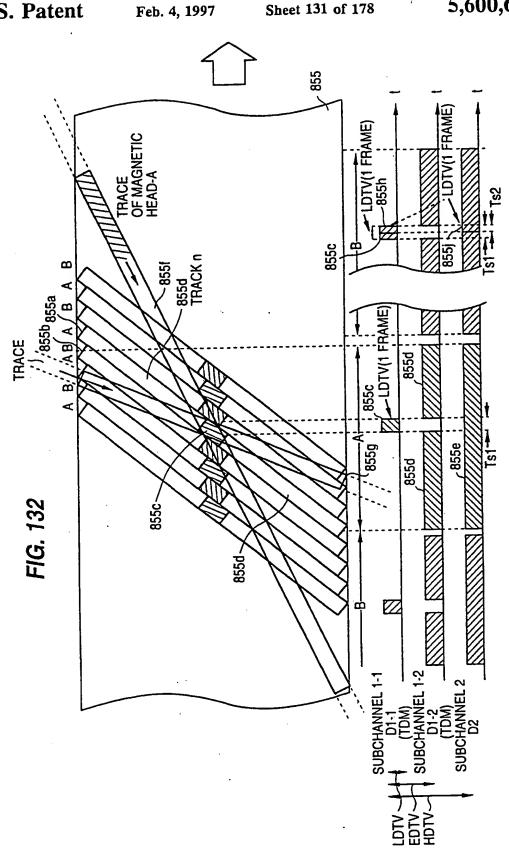


FIG. 131



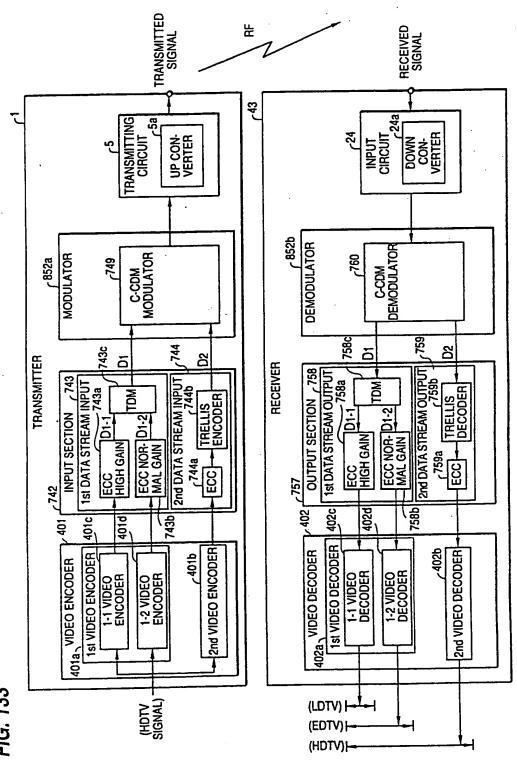
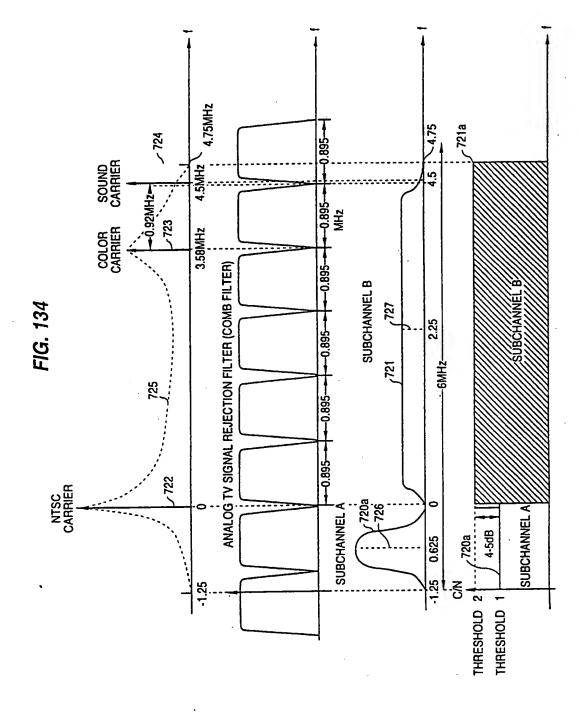
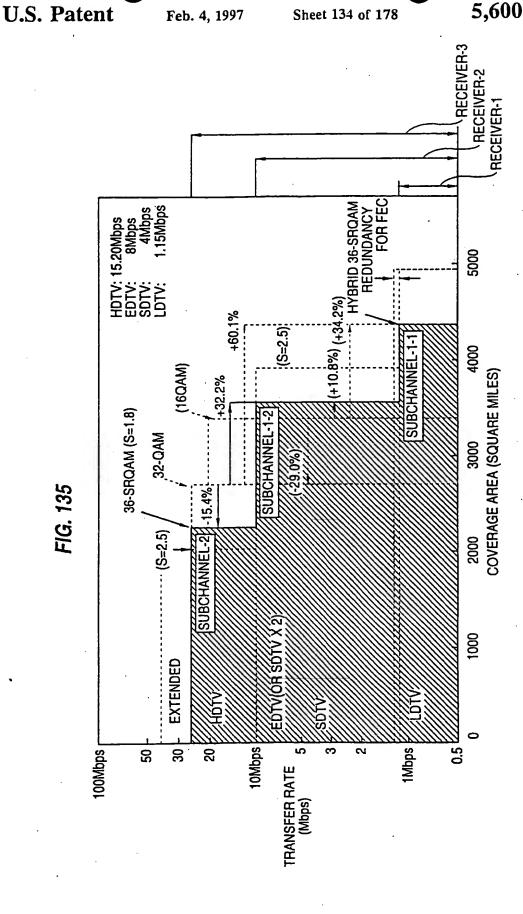
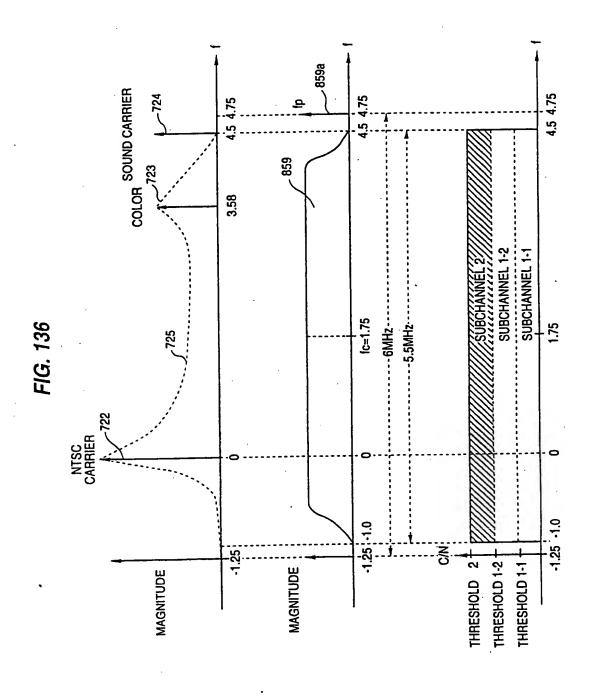


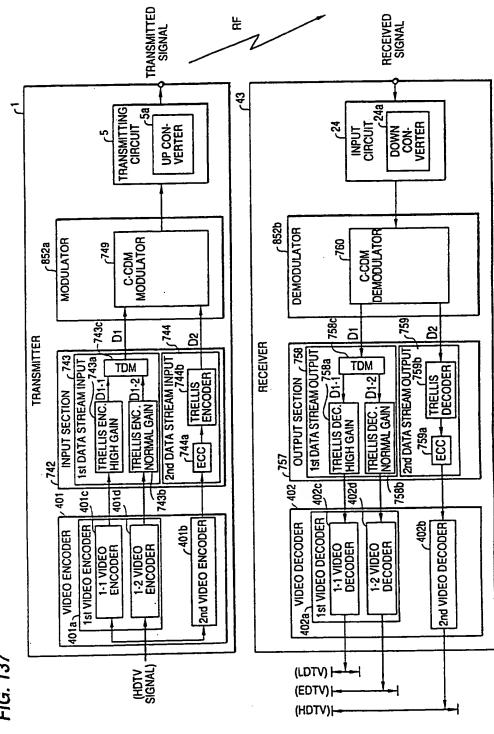
FIG. 133











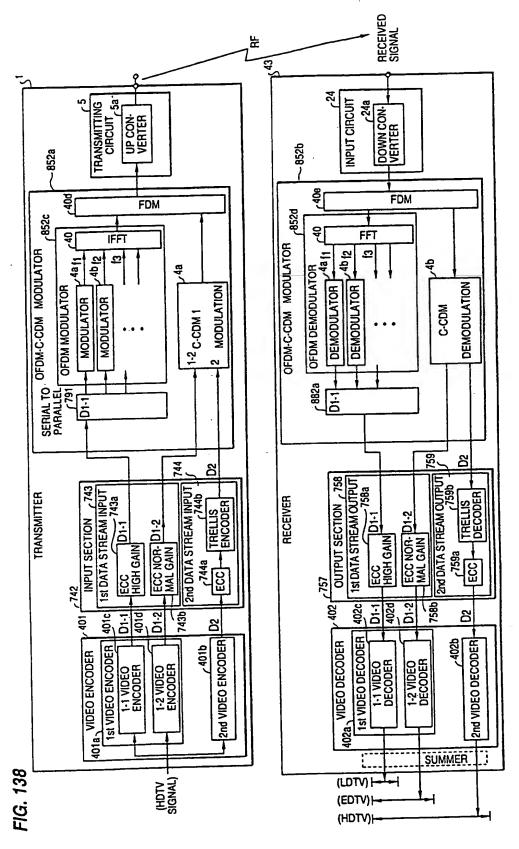


FIG. 139

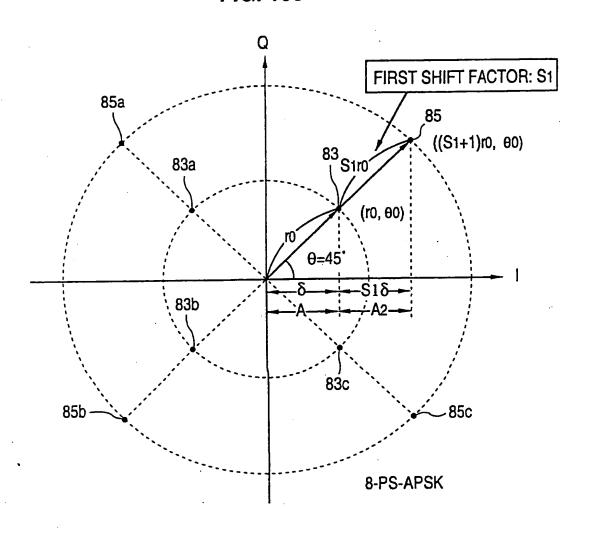
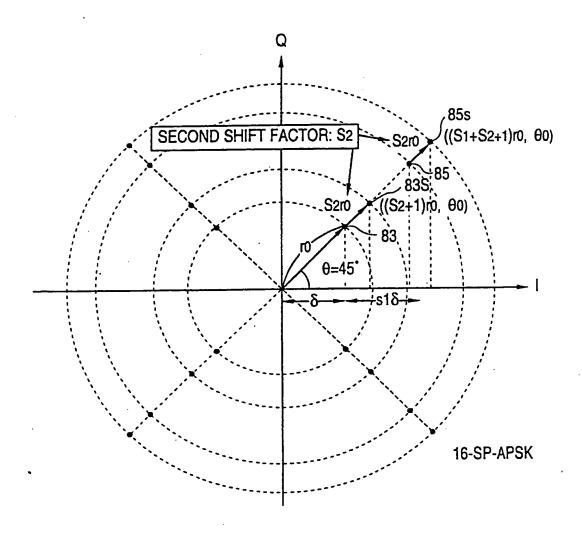
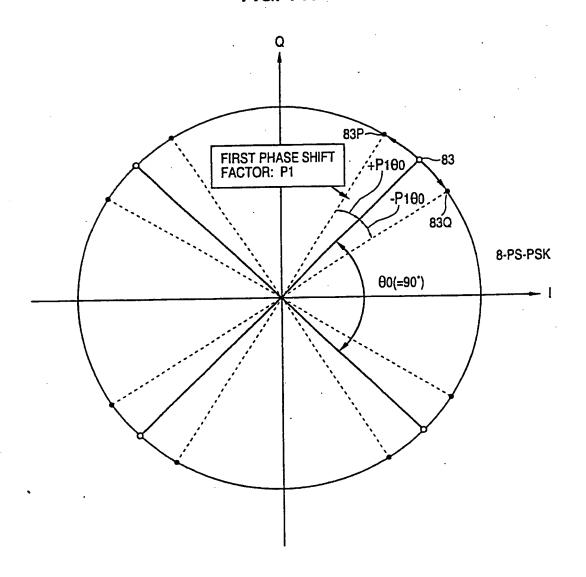


FIG. 140



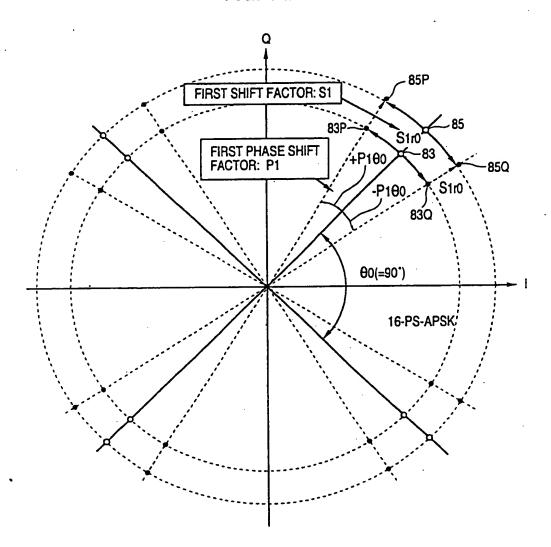
Fre the law were will be the calls of the best that the same that the

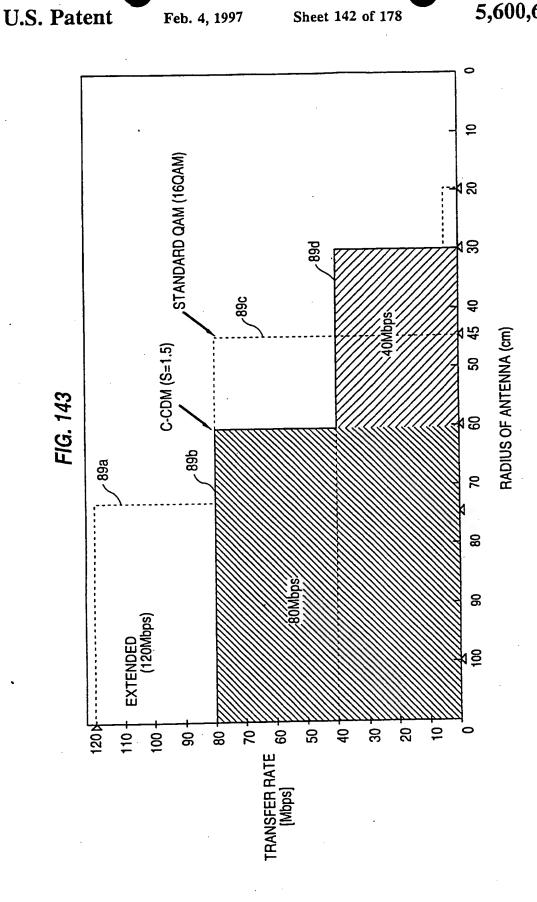
FIG. 141



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FIG. 142





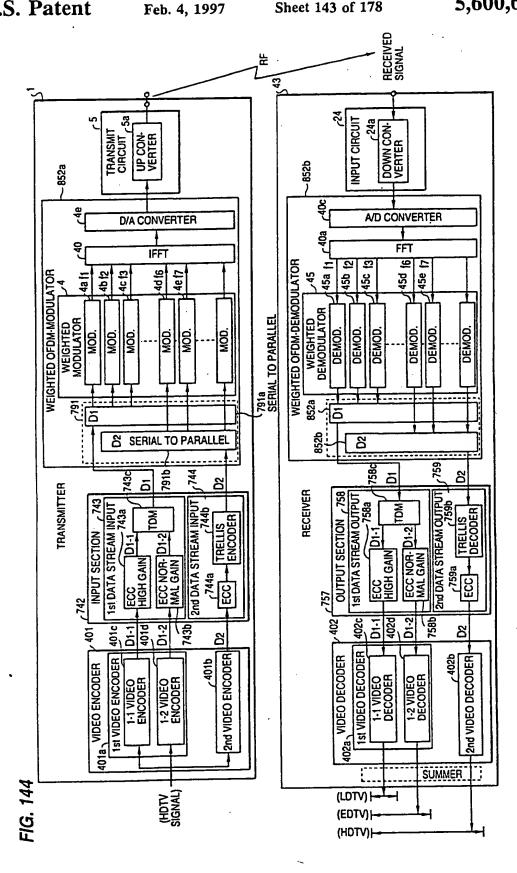


FIG. 145(a)

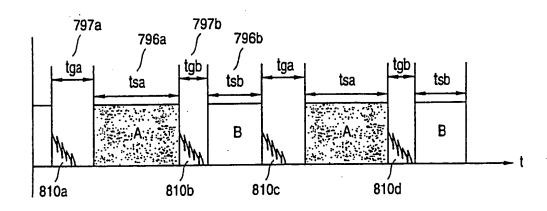
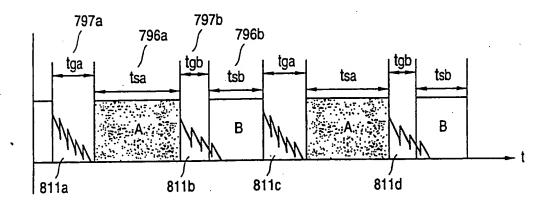
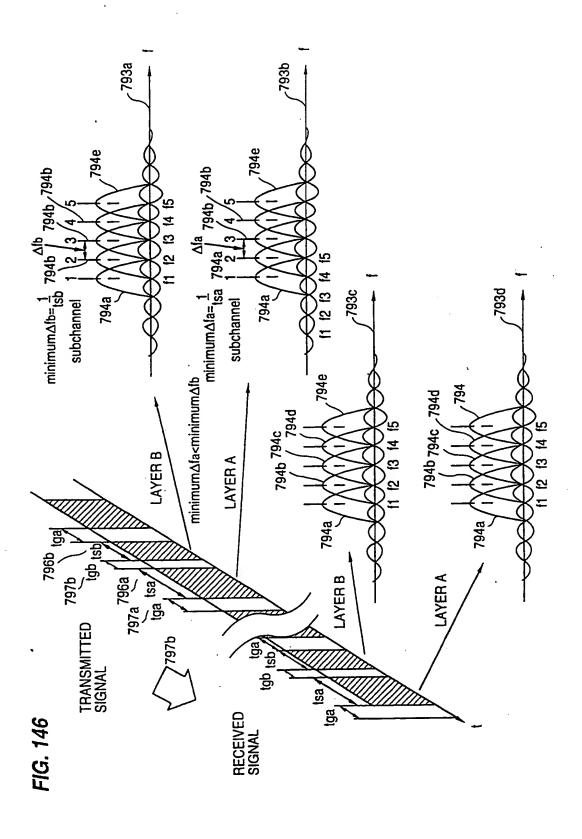
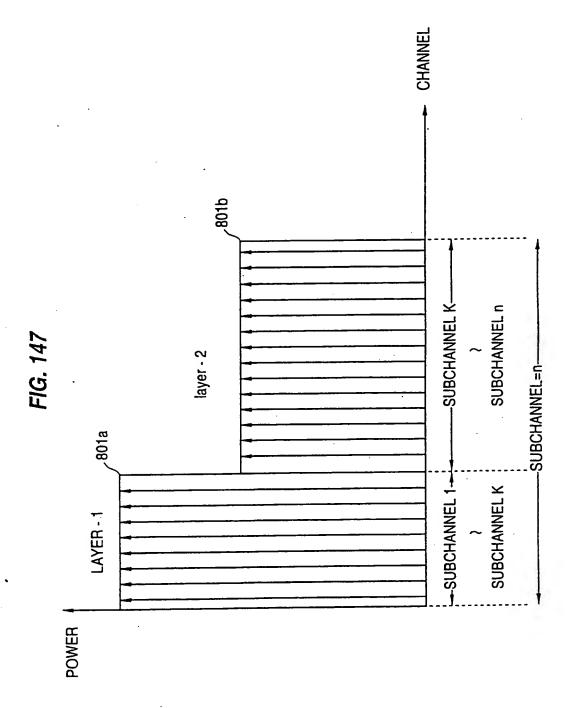
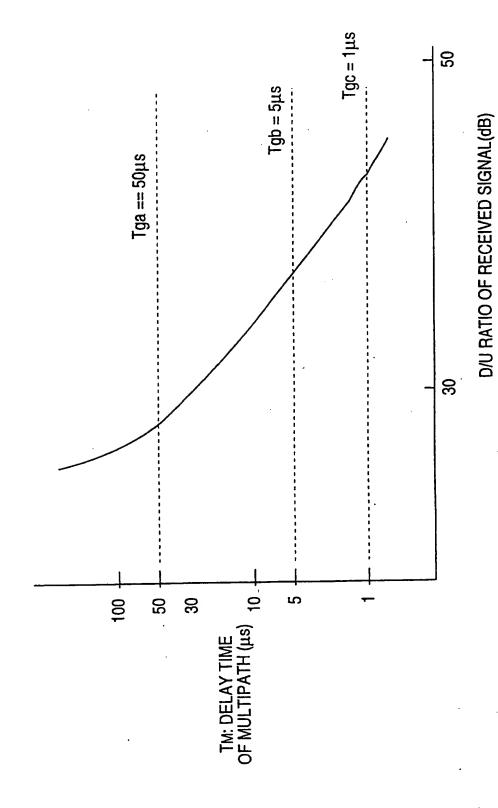


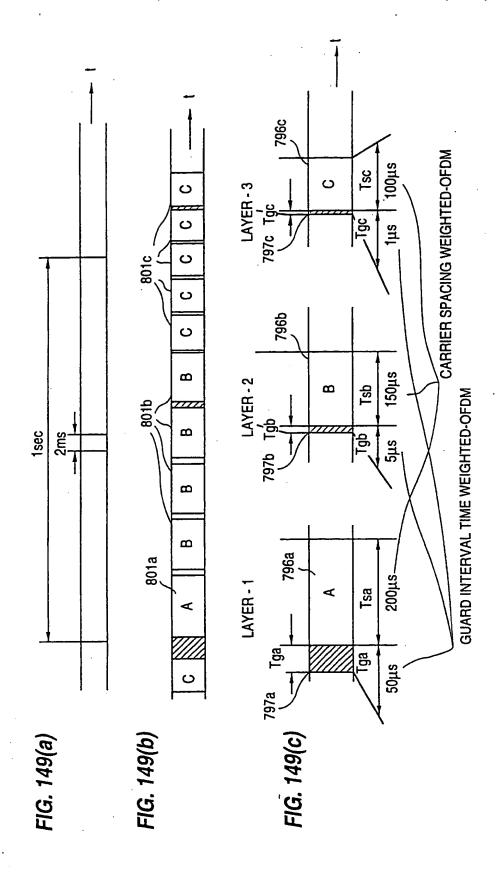
FIG. 145(b)

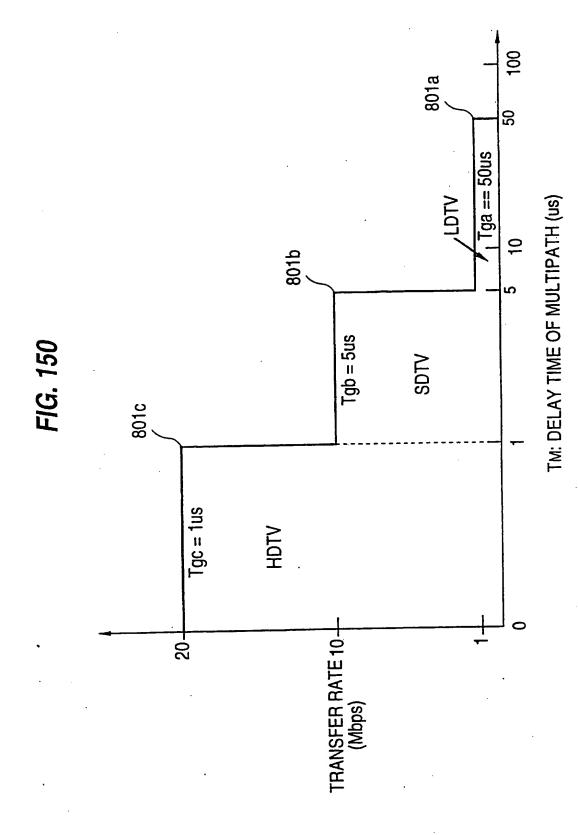


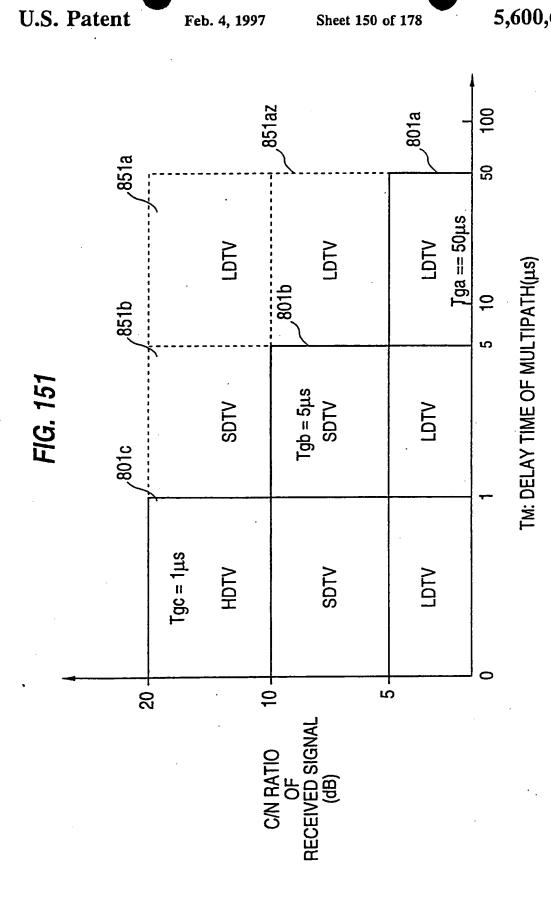


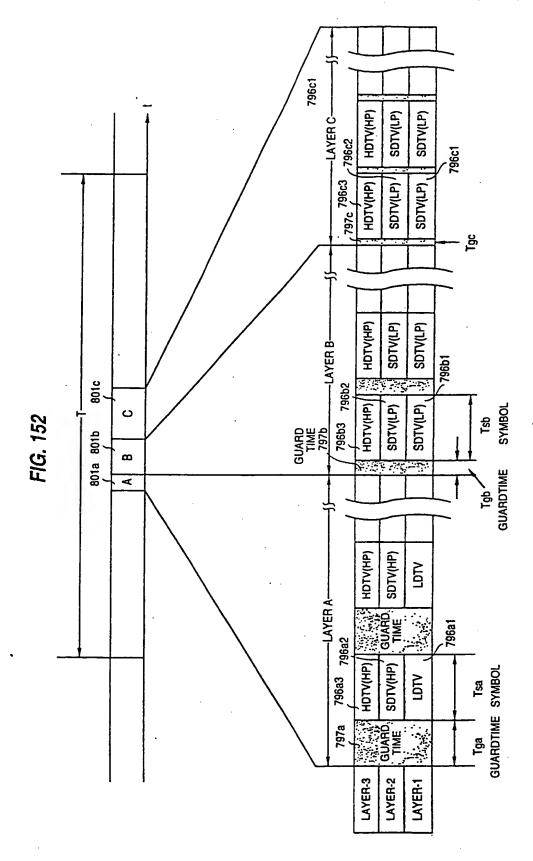




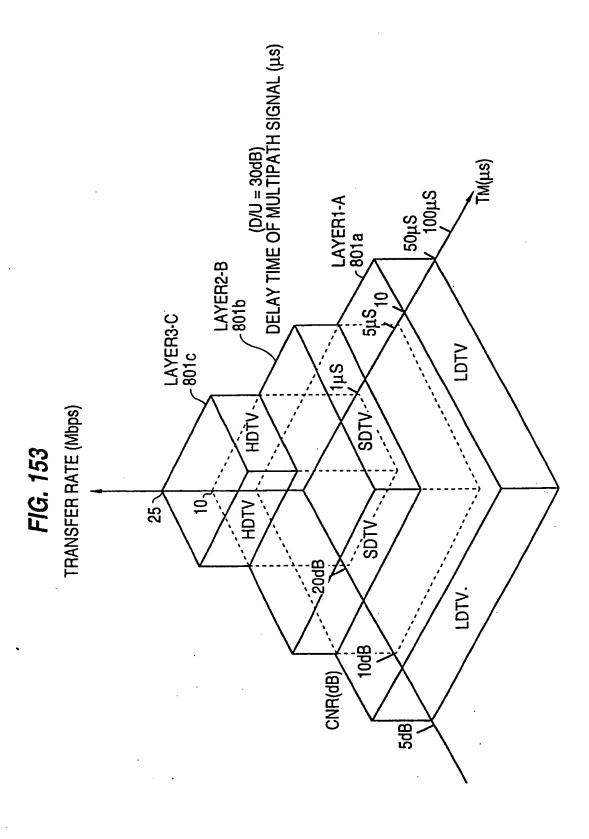


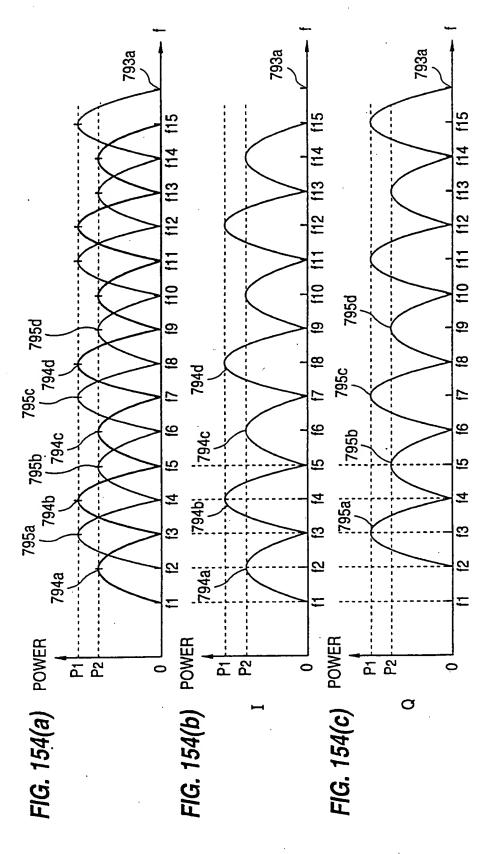


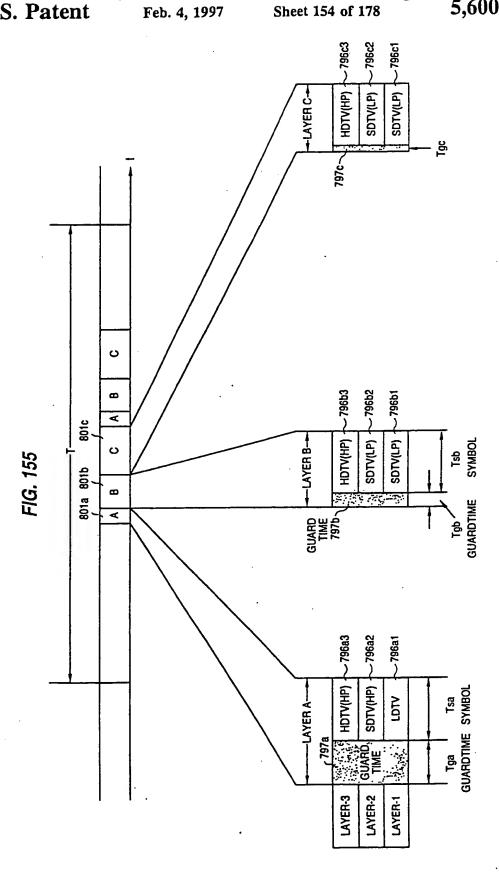












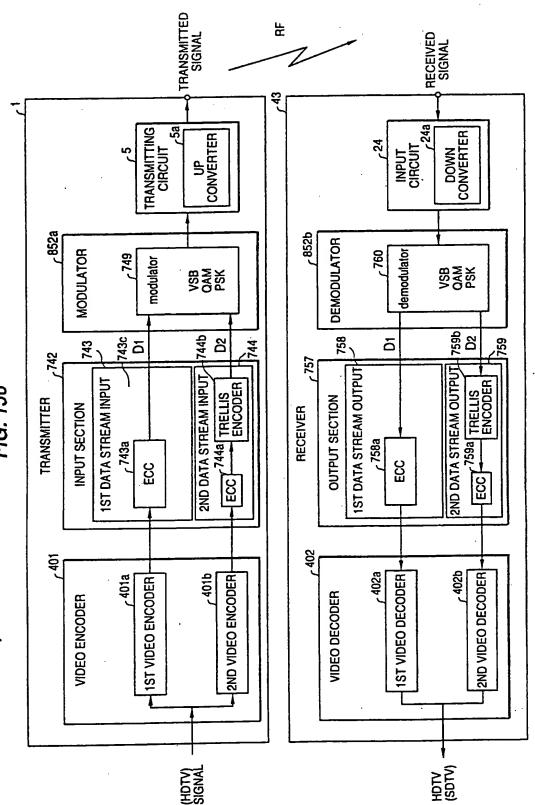
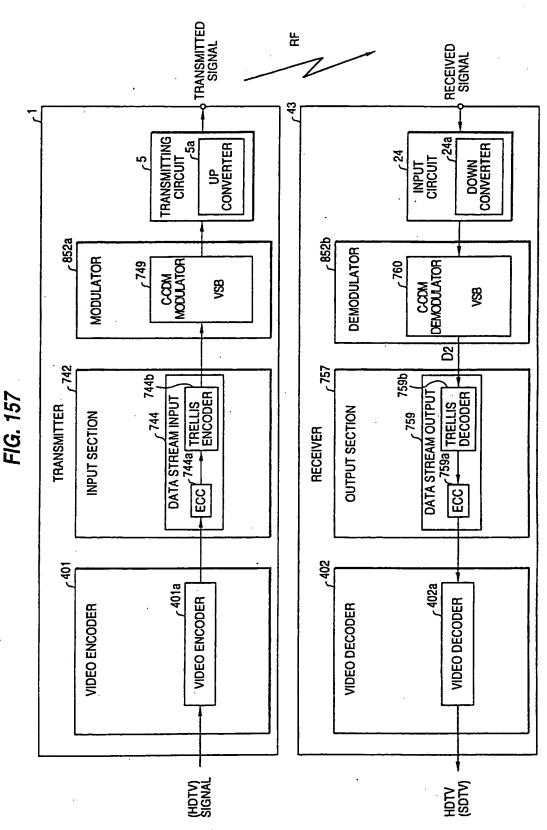
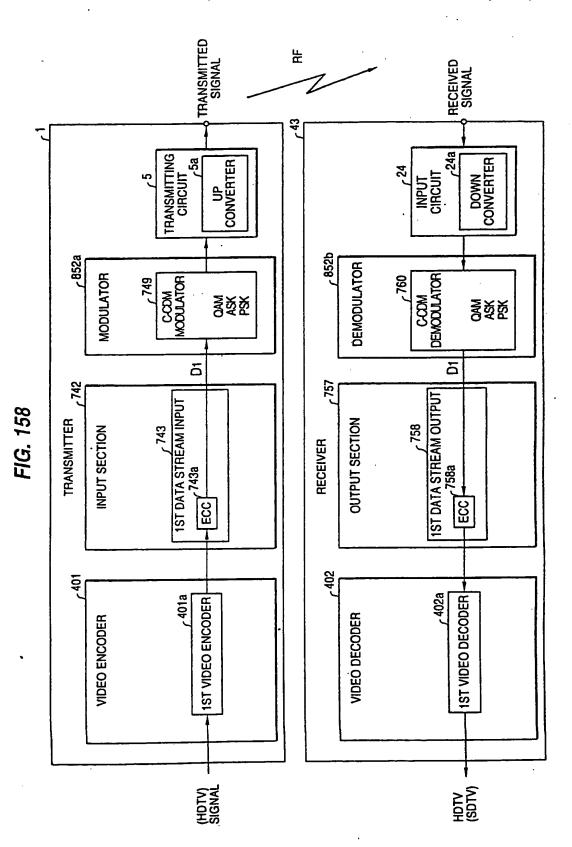
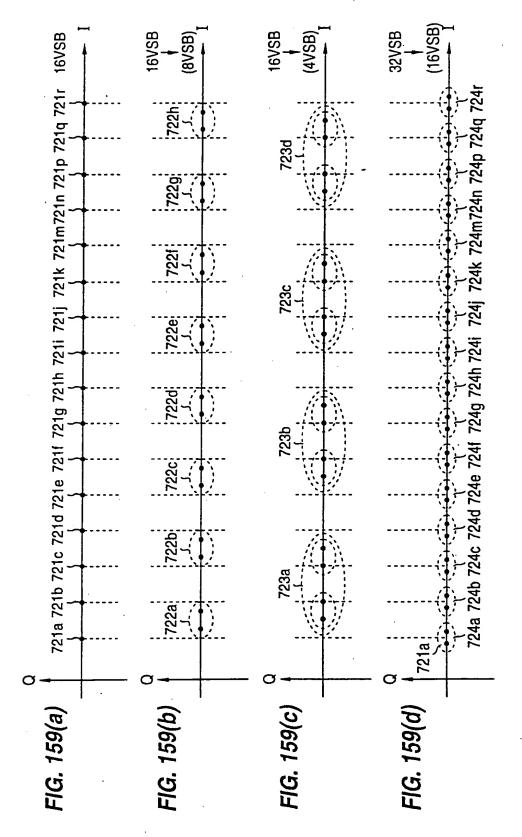


FIG. 156

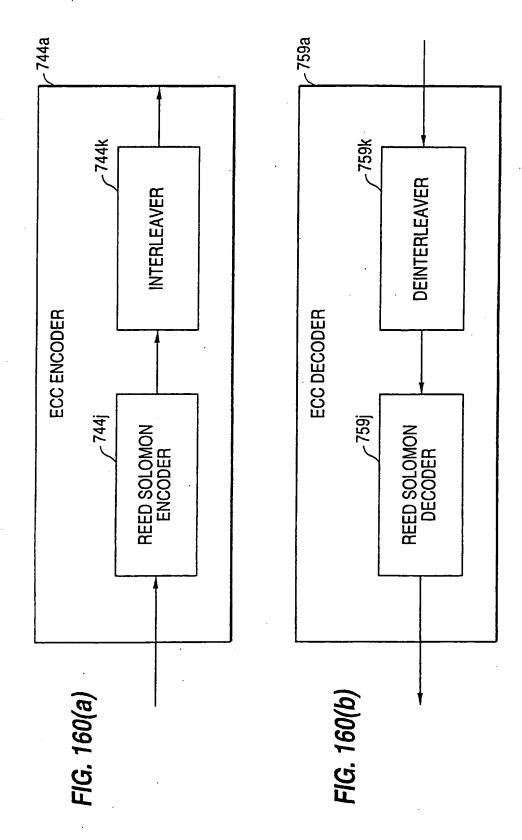
U.S. Patent



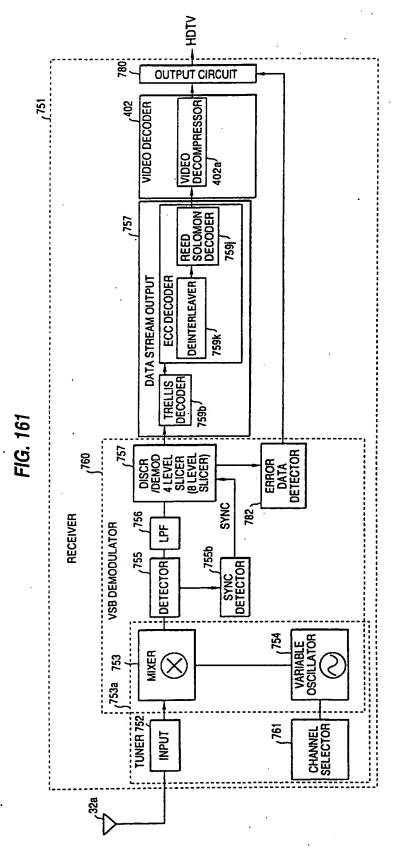




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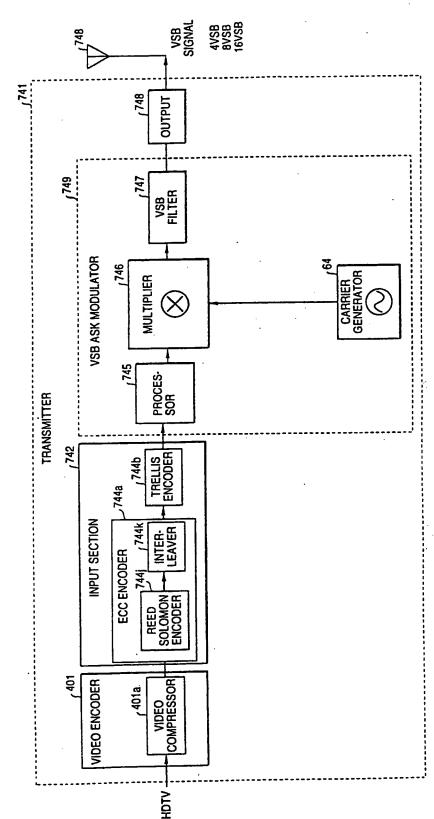


FIG. 163

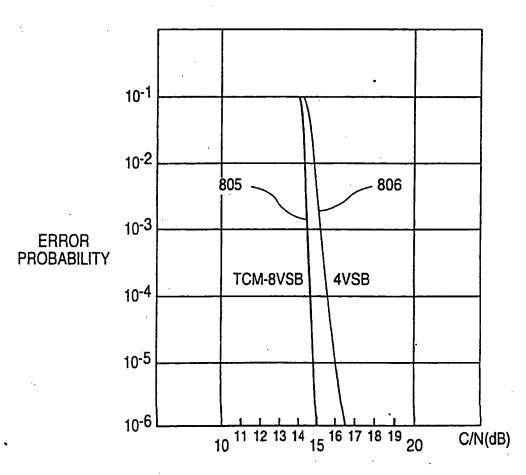
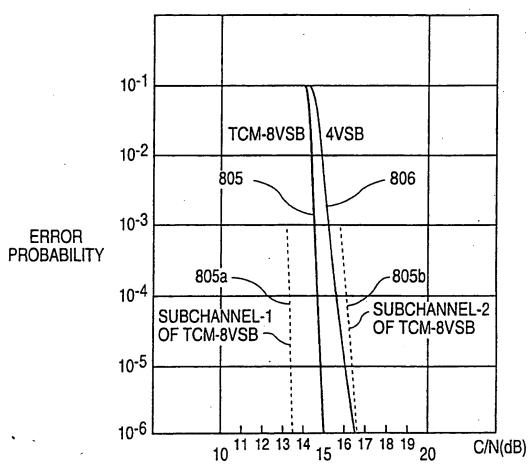


FIG. 164





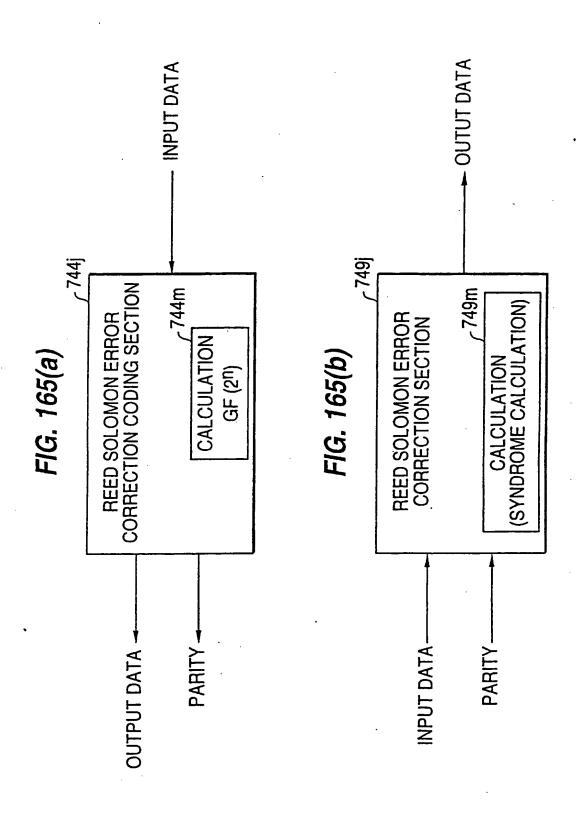
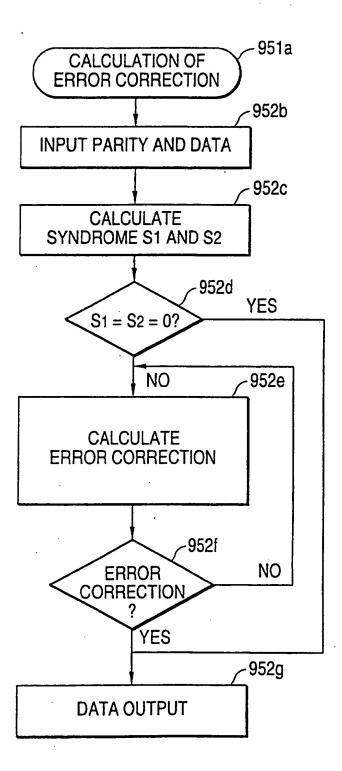
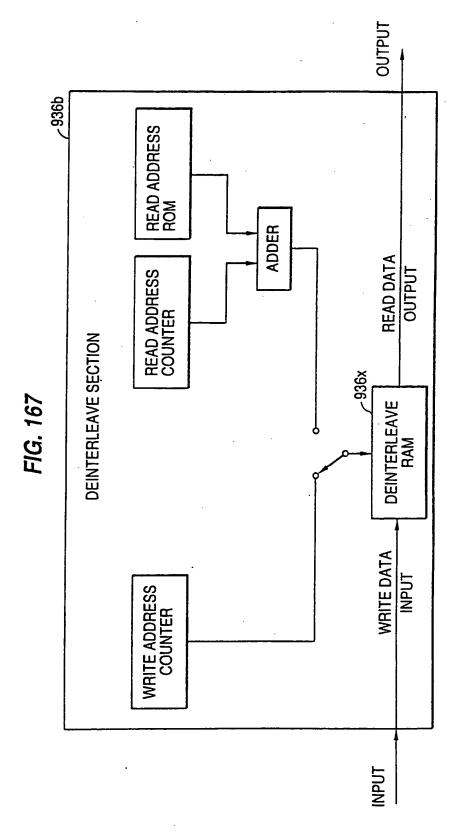
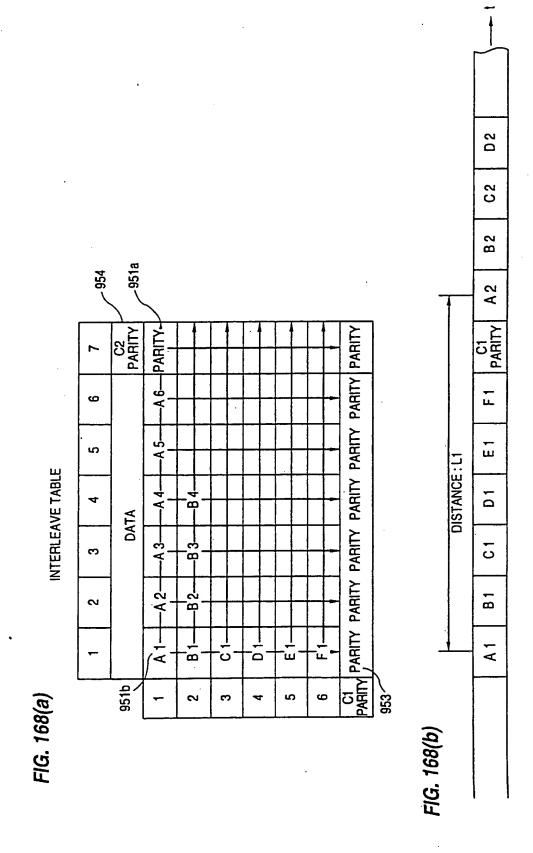


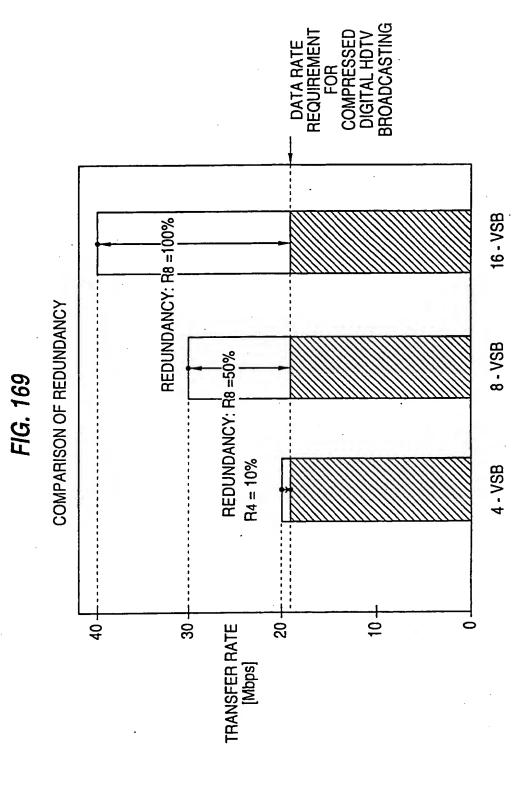
FIG. 166

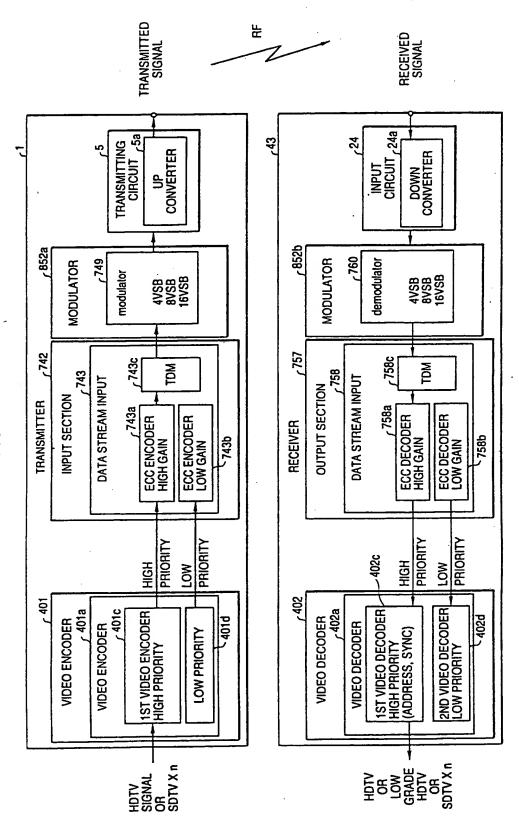


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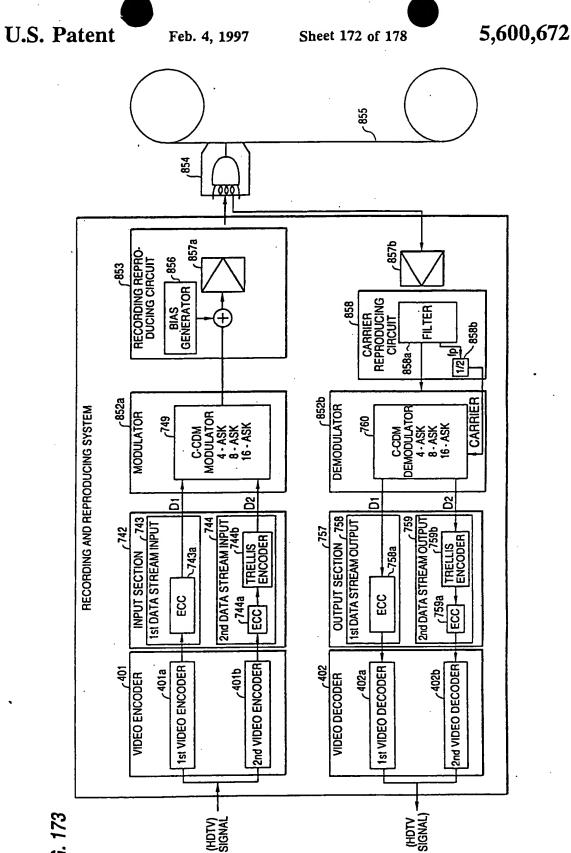
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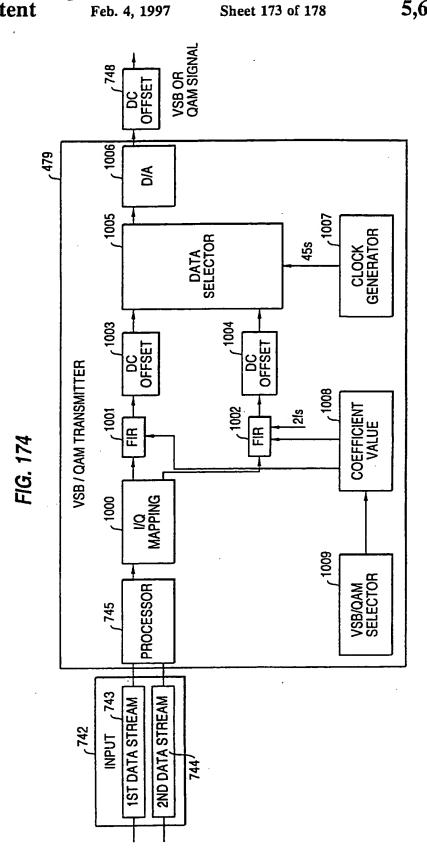
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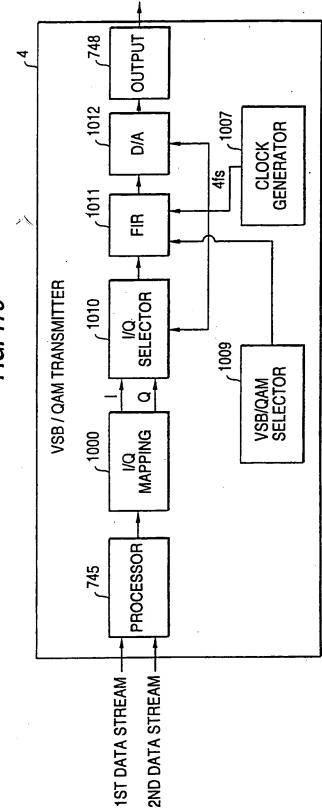
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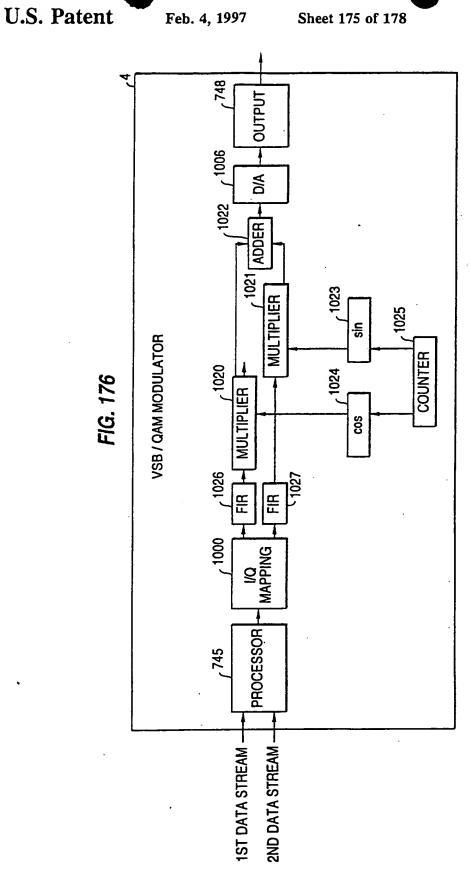


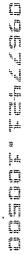


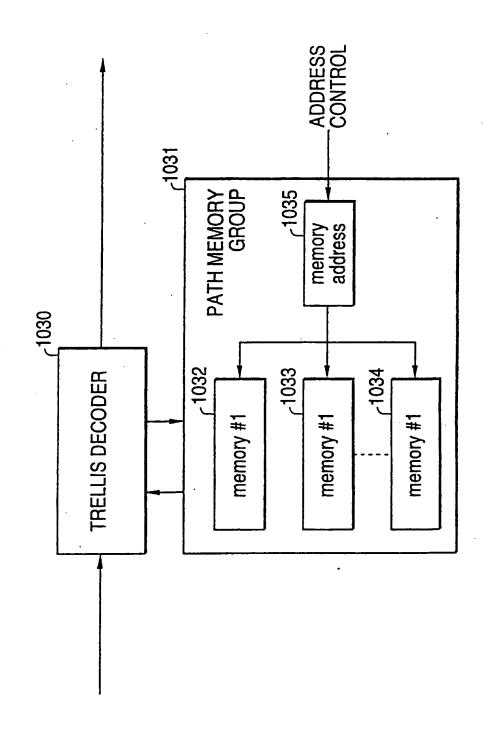


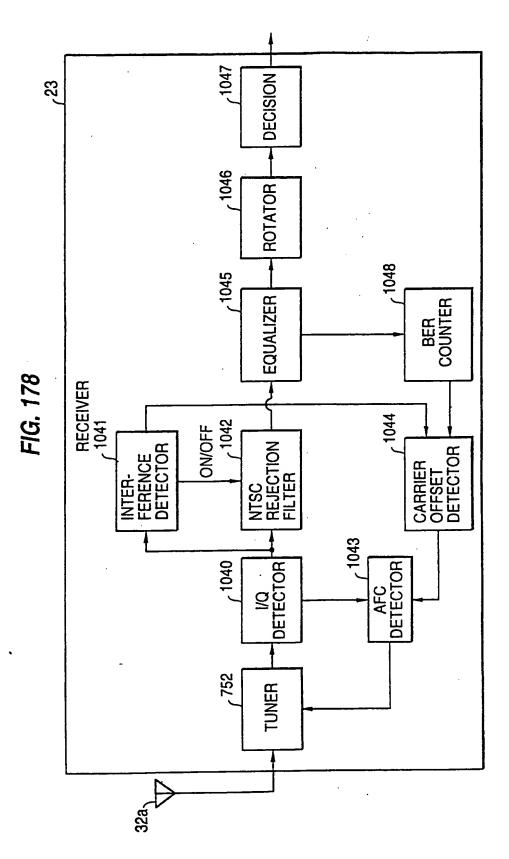
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